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The purpose of this study was to identify the trained manpower needed to cope with Indiana's mounting problems in air and water pollution control, liquid and solid waste disposal, and water supply and resources. This report contains data concerning the present employment, current job opportunities, and projected manpower needs for related professional and technician level occupations. Included are details of a proposed associate degree program designed to prepare pollution control technicians. A 22-item selected bibliography, sample copy of the questionnaire used, appendixes and numerous statistical table s are included in the report. (CH)

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MANPOWER REQUIREMENTS for POLLUTION CONTROL and WATER RESOURCES in INDIANA and a RELATED POLLUTION CONTROL TECHNOLOGY CURRICULUM

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MANPOWER REPORT 69-1

24 FEBRUARY 1969

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Manpower Requirements for Pollution Control and Water Resources in Indiana and a Related Pollution Control Technology Curriculum

The purpose of this study is to identify the trained manpower needed to cope with Indiana's mounting problems in air and water pollution control, liquid and solid waste disposal, and water supply and resources. This report contains data (acquired through an extensive survey) concerning the present employment, current job vacancies, and projected manpower needs for related professional and technician-level occupations.

Also presented in this report are details of a proposed associate degree program designed to prepare pollution control technicians that was included with the survey. Respondents reacted to the curriculum, gave some constructive suggestions, and indicated their willingness to hire graduates at reasonable salaries.

The requirements for examination and certification of technicians in fields of related work are discussed, and a bibliography is attached.

***

This manpower report was prepared in part under the auspices of the Purdue Water Resources Research Center and is also published as Technical Report No. 6 of the Center. The study was conducted with the assistance of the following advisory committee members:

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Professor J. P. Lisack, Associate Professor of Industrial and Vocational Education;
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Professor H. R. Wilke, Professor of Sanitary Engineering.

Acknowledgement is gratefully made to Mr. Crawford F. Parker, Administrative Vice President and Mr. Harold L. Schuman, Executive Vice President of the Indiana Manufacturers Association; Mr. William L. Hafner, Secretary-Treasurer of the Indiana Section of the American Water Works Association; and Mr. Chester H. Canham, Secretary, Indiana Water Pollution Control Association.

The work of Mr. Herbert M. O'Neill, research assistant, is also gratefully acknowledged.

Note: Copies of this report -- and those listed on pages 62, 63, and 64 are available at $1.50 (Indiana Government and Educational offices exempted.) Please send order to Prof. J. P. Lisack, Director, Office of Manpower Studies, Purdue University, SCC-A, Lafayette, Indiana 47907.

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CHAPTER I

PURPOSE and DESCRIPTION of the REPORT

1. The Problem and the Promise. -- "Once upon a time there was a B-i-i-i-g yellow ball in the sky. It was called the sun..." So read the caption under a cartoon showing a teacher reading a story to some youngsters at her feet, with a background of tall smoke stacks feeding huge, billowing black clouds overhead. Boy Scouts are taught "Don't drink water directly from any river, lake, or stream"... and so it goes on and on.

Since the national supply of water is relatively constant and its use and reuse is increasing with growing industry and the expanding population, the problems of controlling water pollution are becoming more complex.[1] In fact, technological advances generally are being bought at the cost of increasing deterioration of the environment; pollution of the atmosphere and water, mountains of waste, unpleasant and unhealthful conditions. Time to control and solve these problems is running out.

There is hope. Within the last few years the Nation and States have committed themselves to accelerated programs to clean up the air and water, preserve water resources, and dispose of wastes more efficiently. It is estimated that national expenditures for facilities to treat industrial and municipal wastes alone have amounted to over $1 billion in the past year and $9 billion in the past 14 years... even greater expenditures will be required in the years ahead.[2]

Inland Steel's Harbor Works Plant (East Chicago, Indiana) provides a local example of the costs for pollution control (air, liquids, and solids). Their cost for pollution abatement equipment to date has been about $43 million, and by 1970 it will be almost $50 million due to the fact more anti-pollution devices are to be built into recently announced projects.[3]

The Nation and the various States have already adopted many -- and are now evolving even more -- new standards, regulations and laws. Air pollution is beginning to receive increased emphasis (viz. The Air Quality Act of 1967 by the United States Congress, and the Indiana Air Pollution Control Law enacted by the General Assembly).[4] However, the degree to which we will breathe a little easier and have clean water, and rid ourselves of the mountains and rivers of waste we generate, will depend to a large extent on the availability of trained and qualified manpower.

2. The Personnel Equation. -- The next few years will witness a rapid increase in demands for personnel of all types in pollution control, water and waste program activities. This manpower need will extend from post-graduate trained scientists and engineers at research sites, to the staff required for day-to-day operations of tens of thousands of operating plants, facilities and offices. Indiana will not be exempt. To do much about this need requires knowledge of current employment, existing job vacancies, projected requirements and educational needs.

[1]/.... Refers to reference number in Appendix I, Selected Bibliography on page 35.

As one indication of the recognition and scope of the manpower problem in the area of water pollution control, the Congress of the United States required the Secretary of the Interior to study and publish a Senate document entitled "Manpower and Training Needs of the States and of Local Governments in Water Pollution Control."[2] Although this document did not identify the needs of the separate States, the National requirements were presented, and some general applications to Indiana can be made. The report gave specific requirements for professionals, technicians, operators and assistants in water and sewage treatment plants for State and local agencies as well as for industry and others.

These National requirements are described below - with the approximate Indiana portion computed and explained by the author. Extracts from the report are shown as quotes and each is followed by an explanation.

> "1. The current levels of employment have been determined and future needs estimated for qualified professional employees, technicians, and sewage treatment plant operators to staff State and local agencies. In every case, the estimates are believed to be highly conservative and are exclusive of replacement needs. It has been found that--
>
> (a) About 3,600 scientists, engineers, and related professionally trained personnel are now employed by State and local agencies. By 1972, about 9,000 should be employed. Thus, a minimum of 5,400 additional trained professionals will be needed by State and local agencies within the next few years, an increase of 150 percent. Increasing complexity of pollution problems will undoubtedly require that many of these future employees have a higher degree of training and that more professional disciplines be represented than in present-day operations."[2]

Inasmuch as water and sewage treatment is related to population in a direct way, a general finding for the needs of any given State can be derived by determining the percent of the total National population that resides in the State. It follows then that Indiana having some 2.5 percent of the total population will require about 120 additional trained professionals within the next few years in clean water programs alone, (these are exclusive of replacement needs.)

***

> "(b) About 2,600 technicians are now employed by State and local agencies for work in laboratories and in the conduct of field studies. It is estimated that about 6,500 will be needed by 1972. This represents an increase of 3,900 over a 5-year period; that is, of 150 percent."[2]

It follows then that Indiana may require about 100 additional technicians for clean water laboratory and field study work in the next few years, exclusive of replacement needs.

***

> "(c) Approximately 20,000 persons are employed for the operation of municipal sewage treatment plants. An estimate of needs, based on the authorized increases in Federal financial support to communities for construction, indicates 30,000 trained operators will be needed by 1972."[5]

Indiana's portion of the additional 10,000 sewage treatment plant operators based on a division by population would be 250 newly trained operators.

***

> "(d) An additional 50,000 persons are employed as operator assistants and in maintenance of sewage systems."[5]

This represents an impressive total of 1,250 maintenance assistants that are employed in Indiana. Assuming a 15 percent annual attrition rate, this would mean that approximately 175 new operator and maintenance assistants would be needed each year in Indiana.

***

> "2. The personnel needs of State and local agencies cannot be considered independent of the total personnel needs of other employers in the field. Consulting engineers, suppliers of chemicals and equipment for waste treatment plants, and Federal agencies also have substantial demands for trained personnel. These employers, essential to the national clean water efforts, compete directly with State and local agencies for manpower and for use of training resources. As such, they must be taken into account to obtain a balanced understanding of the trained manpower equation. For example:
>
> (a) It is estimated that 12,000 plant operators and 6,000 professionals will be required in 1972 for the 6,000 industrial waste treatment plants. This compares with a 1967 estimated employment of 1,700 professionals and 3,500 plant operators. The manpower requirements for industry will probably increase 250 per cent by 1972.
>
> (b) It is expected that needs by consulting engineers' firms for engineers and other professionals will increase from today's 6,000 to 21,000 by 1972. Also, consulting engineers are likely to need 15,000 more technicians."[5]

Again applying the 2.5 percent population factor, these industry requirements add 100 professionals, 375 technicians, and 200 plant operators in Indiana. When these needs are combined with requirements to staff State and local agencies, the totals for new personnel in Indiana by 1972 become 220 professionals, 475 technicians and 450 plant operators. In addition, attrition from jobs must be filled for these groups and for the 1,250 maintenance assistants in sewerage plants.

***

> "3. The number of personnel employed and needed tells only part of the story. There is convincing evidence that levels of training and degrees of skill are at least equal in importance. Personnel who are not adequately trained, or whose training is out of date, are unlikely to be able to carry out their job responsibilities at acceptable levels of competence or efficiency."[5]

"Money Isn't Pollution Removal" is the title of a recent editorial of the Engineering News-Record.[6] The frank and blunt statement is made "But a gold-plated [pollution treatment] plant isn't worth a tinker's dam without trained specialists to run it. For example, to treat Boston sewage, the Metropolitan District Commission has a new $20 million plant, but skilled help is so short that the plant does little but pump raw sewage... Philadelphia Water Commissioner Samuel Baxter testified before Congress two years ago when he was president of the American Water Works Association that he seriously doubted whether we had enough depth of technical manpower talent to extract full benefit from spending on the scale then proposed." The editorial concludes with the sentence "...we should not propagandize ourselves into the erroneous assumption that water pollution abatement depends only on getting more money."[6] So it boils down to an element common to most of the technical problems confronting us, the need for well-trained and qualified people.

3. Purpose and Rationale of this Study. -- This study was designed by the members of an advisory committee who were selected for their experience, knowledge and interests in the fields of air and water pollution, water resources, sanitation and waste disposal. Committee members included a chemist, who is also an air pollution expert and consultant, sanitation and civil engineers, a water works superintendent, a life scientist, educators and other pollution control consultants.

It was decided first to capitalize on all present data available in the literature and through personal contacts in order to identify and define the occupations concerned at the professional level (baccalaureate or higher degree) and the technician level (normally two-year associate degree). The quantitative manpower data needed would then be obtained through a comprehensive State-wide survey of key activities, firms or agencies, and would include, (a) number now employed in each occupation, (b) additional staff needed now, and (c) estimated number needed from outside sources to fill vacancies (attrition) and new jobs (expansion) for the next five years.

The committee members agreed with the Senate document findings that the educational and training programs for professionals (scientists and engineers) were generally satisfactory,[5] but that such was not the case for technicians. Therefore, it was decided that a proposed pollution control program (two-year associate degree, college level) should be developed, and suggestions concerning its adequacies or weaknesses be obtained as part of the manpower survey. The needs for graduates of such a program (quantitative and geographic location) and the estimated monthly salary they might be paid were also asked for. Finally, survey respondents were asked to identify what other courses, programs, seminars or other training actions were needed.

4. Contents and Format of This Report. -- This first chapter presents the introduction to pollution control, water and wastes problems, the personnel implications, the rationale and methods used to acquire data, - and explains the format of the report. Chapter Two describes the survey used and provides the resulting manpower data in a series of tables; highlights and general implications are pointed out.

The third chapter deals with the implications of training pollution control technicians and includes the hypothesis on which a proposed curriculum was built. The acceptance and comments of survey respondents concerning this curriculum, and the need for graduates and estimated starting salaries are included. Discussions of the examination and certification of technicians, use of advisory committees, student membership in associations and need for short courses or seminars are also presented.

The conclusions and recommendations are offered in Chapter Four. **

A selected bibliography, sample copy of the questionnaire used, appendices and numerous statistical tables are included at the end of this report.

**Duplicated on yellow paper for convenience.

CHAPTER II

QUESTIONNAIRE DISTRIBUTION, RESPONSE and ANALYSIS

5. Description of the Survey Packages. -- The basic survey was made up of four parts; (1) a letter of transmittal, (2) the questionnaire, (3) the proposed pollution control associate degree program, and (4) occupational titles and definitions related to the survey. The occupations were grouped into the two major categories of Professional and Technician. (The professional group had eight engineering occupations and five scientific; the technician group had nine occupations.) A slight variation of this basic survey was used for selected addressees in government and educational institutions -- these are explained in the next section. A sample copy of the basic survey is attached as Appendix II. Each of the survey's four parts are explained below:

a. Letter of transmittal, which described the problem of pollution control, explained the survey package and asked for cooperation.

b. The questionnaire, a simple two page instrument having four parts:
(1) identification of the name and organization of the respondent;
(2) number now employed in each occupation, additional staff needed now, and estimated number needed from outside sources in the future;
(3) questions concerning the adequacy of the proposed pollution control curriculum, whether or not graduates would be hired, and the estimated starting salary; and finally
(4) respondents were given an opportunity to identify any other courses, programs or seminars needed and make any further comments.

c. The Proposed Pollution Control Technology Program, general objectives and description followed by a tentative listing of each course for the four semesters, and

d. Occupational Titles and Descriptions of the professional and technician occupations related to the pollution control, water, and waste fields. Respondents were given an opportunity to write in any additional occupational titles and needs.

6. Questionnaire Distribution and Response. -- It was decided that members of five major organizational groups were appropriate to the survey. These were: the Indiana Manufacturers Association (IMA), Indiana Section of the American Water Works Association (AWWA), the Indiana Water Pollution Control Association (IWPCA), selected Indiana colleges and universities, and selected Federal and State agencies located in Indiana. This latter group included the State Department of Natural Resources, State Board of Health, State Department of Commerce, U.S. Soil Conservation Service, Federal Water Pollution Control Agency, U.S. Geological Survey, U.S. Corps of Engineers, U.S. Weather Bureau, and the Wabash Valley Interstate Commission. Survey packages were mailed to nearly 3,000 addressees: there were more than 600 returns representing a return of over 20%.

The mailings and response details are presented in Table I.

Table I - SURVEY RETURNS by ORGANIZATIONAL GROUP MEMBERS

Members of:	Number of Questionnaires Mailed	Number of Responses Returned*	Percent Returned
Indiana Manufacturers Assoc. (IMA)	1531	421	27.5%
Indiana Section: American Water Works Assoc. (AWWA)	1113	111	10.0%
Indiana Water Pollution Control Assoc. (IWPCA)	311	46	14.8%
Indiana Colleges and Universities	25	18	72.0%
State and Federal Agencies (Located in Indiana)	8	8	100.0%
TOTAL	2,988	604	20.2%

The percent of returns is actually higher than indicated because some members of one association were also members of others in spite of an effort to reduce such duplications. Further, in a number of instances, replies for a number of activities (e.g., in a municipality) were combined on one return.

In the case of manufacturing firms, 27.5% of the firms surveyed returned the completed questionnaire; however, these firms represented over 300,500 employees which is about 42% of the total employment in Indiana manufacturing industries. There might have been some hesitancy to respond on the part of some firms due to a fear of implied self-incrimination by admitting to a shortage of personnel in pollution control. The specific returns from manufacturing firms and representations in detail are presented as Appendix III.

The response from the members of the Indiana Section -- American Water Works Association is more significant than the number indicates. The number of questionnaires sent is about double the number of public water suppliers in Indiana. There were 1113 questionnaires mailed out but there are only 593 communities in Indiana served by public water supplies. The difference is made up of engineers, accountants, other individuals, and manufacturers and distributors of equipment. Further, of the 593 communities served by public supplies, one third have 300 customers (1000 population) or less, and thus are one-man, (or part-time) operations. Fewer than 50 suppliers serve communities having a population of 10,000 or more. Under these circumstances the 111 replies from water works assume greater significance than first appears, probably representing chiefly the major suppliers. Other considerations besides size undoubtedly affect these returns, too. A respondent may make no reply because of a variety of reasons, such as being a political appointee with no particular interest in his job... or he may not reply because he is conscious of short-comings that he does not want to call attention to.

*For distribution of returns by Regions in Indiana, See Appendix VI.

All the four year colleges and universities in Indiana were mailed the questionnaire regardless of emphasis of their curricula.

Representatives from the State and Federal agencies concerned worked closely with the study and were aware of its progress. They participated in the development of the questionnaire and occupational definitions. This may account for the 100% response from this group.

> Note: There has been no effort in this study to expand the survey results to a universe including those not responding or not surveyed. Therefore, the employment, job vacancies and projected requirements should be viewed as minimum or lower parameter situations.

7. Summary of Employment and Job Vacancies by Occupational Groups. -- As was stated earlier, the three occupational groups surveyed included engineers, scientists and technicians: of the employment distribution in these 3 groups, nearly 36% were engineers, another 36% were technicians, and 28% were professionals in physical or life sciences. The 604 firms and offices responding to the questionnaire reported they had a total of 859 jobs for engineers in the pollution control, water resources, and waste disposal areas... and that 16 percent of these jobs were now vacant. The respondents reported 652 jobs for physical and life scientists - with about 17 percent vacant. Nearly half of the 16 social scientist positions were vacant. In the engineering technician group, of the 727 jobs reported, more than 20 percent were vacant; and nearly 20 percent of the 137 physical and life science technician jobs were vacant. With these many additional staff members needed now, and with accelerated pollution abatement plans for the near future, the serious technical manpower deficiencies become apparent in these broad occupational groups. Table II presents the current employment, additional staff needed now, and distribution of these occupational groups.

Table II - SUMMARY of JOBS by OCCUPATIONAL GROUP

Occupational Group	Number Employed	Additional Staff Needed Now	Total Number of Jobs	Job Distribution
Professional Engineers	720	139	859	35.9%
Physical and Life Science Professionals	540	112	652	27.3%
Engineering Technicians	577	150	727	30.4%
Physical and Life Science Technicians*	112	25	137	5.7%
Social Scientists**	9	7	16	.7%
TOTAL	1,958	433	2,391	100.0%

*Includes 70 Soil Conservation Technicians reported by the U.S. Dept. of Agriculture Soil Conservation Service, Indianapolis Office.7/ See discussion in Section 10.

**Applied only to the surveys returned by government agencies, colleges, and universities.

For summary of distribution of requirements by members of organizational groups, see Table X.

8. Employment and Future Requirements for Professional Engineers. -- There were seven specific engineering occupations related to pollution control, water and waste that were identified and defined in the survey mailed to manufacturing firms, water works, and pollution control activities. Respondents were given an opportunity to write in any other engineer they employed in these functional areas. (See Appendix II for occupational definitions used.) The questionnaire mailed to government and educational agencies and institutions in Indiana had 13 engineering occupations: for detailed results from these respondents, please see Table I of Appendix IV. The summary of employment and requirements for engineers from all respondents is presented in Table III below:

Table III - EMPLOYMENT and REQUIREMENTS for ENGINEERS

Engineering Occupation	Number Employed	Additional Staff Needed Now	Average Annual Recurring Requirement*
Air Pollution Control	103	20	25
Sanitary	138	30	20
Wastewater Treatment	79	18	17
Hydraulic	125	17	14
Water Supply	89	8	9
Solid Waste Disposal	15	10	8
Architectural	20	9	4
Mechanical	30	3	3
Radiological Protection	12	5	2
Water Resources Planning	23	3	2
Chemical	15	2	2
Civil	14	1	1
Other	57	13	9
	720	139	116

It is a sobering realization that there are 139 engineering positions open right now in the firms responding to the survey - and an annual recurring need exists for more than 100 engineers in the fields of pollution control, water and waste in Indiana.

---

* The formula applied in computing average annual recurring requirements in this and subsequent charts is:

$$\text{Total Average Annual Recurring Requirement} = NE + NA + \frac{NV}{5}$$

Defined by:

NA = Number needed for Attrition (losses)
NE = Number needed for Expansion (new jobs)
NV = Number of reported Existing Job Vacancies✓

✓(To be filled over a five year period)

As can be seen in Table III, the largest reported annual recurring requirements for *engineers* are in the fields of air pollution control[*], sanitation[**], wastewater treatment, hydraulics, water supply and solid waste disposal. As expected, most of the engineers needed in air pollution were required by manufacturing industries. Sanitary engineers were needed mostly by government agencies and members of the IWPCA. Wastewater treatment engineers were wanted most by manufacturing firms, water works, and IWPCA members. And hydraulic engineers were needed mostly by government agencies. For the distribution of the 116 engineers needed annually - by representatives from organizational groups - please see Table 1 of Appendix IV.

[*] A related Graduate Training Program is being established in the Schools of Civil and Mechanical Engineering. The purpose of the program is to provide specialized and supplemental training for students who will follow careers in Air Pollution Control *per se*, as well as those students in allied fields related to the overall environmental problems of man. Initial student response has been good. Twenty-five students have registered for the first Air Pollution course which is being taught in the Spring of 1969. Five new courses are being developed for the program. A Training Grant Proposal has been submitted which would provide the financial assistance required to expedite program implementation.[8]

[**] The definition of a sanitary engineer as used in this report and survey (Appendix II) was extracted from Public Health Service Publication No. 579.[9]

Note: The distribution of employees, job vacancies, and future requirements, by major organizational membership (manufacturers, water works, government, etc.) is summarized in Table XI. The detailed distributions of each occupation, by regions within Indiana and major organizational membership, are presented in Appendix VI.

9. Employment and Future Requirements for Physical, Life, and Social Science Professionals. -- Four Physical and Life Science occupations were identified and defined in the surveys mailed to manufacturing firms, water-works, and pollution control addressees; they were bacteriologists, biologists, chemists, and industrial hygienists. Respondents could write in any additional occupational titles. (See Appendix II for occupational definitions used.) The questionnaire sent to government agencies and Universities in Indiana was necessarily expanded in the scientific occupations; specifically, there were 17 life scientists, 15 physical scientists, and 4 social scientists. Table IV below presents the summary of employment and requirements for physical and life scientists, and Table V reflects details for social scientists from all respondents.

Table IV - SUMMARY of EMPLOYMENT and REQUIREMENTS for PHYSICAL and LIFE SCIENCE PROFESSIONALS*

Occupation	Number Employed	Additional Staff Needed Now	Average Annual Recurring Requirement
Chemists	129	20	19
Biologists	103	15	9
Bacteriologists	13	5	3
Industrial Hygienists	11	1	3
Other Scientists**	284	71	53*
TOTAL	540	112	87

*See Table VI for University and Government Agency requirements and Tables 2, 3, and 4 of Appendix V for detailed breakdown.

**Most of these requirements are for soil and water conservationists, soil science agrogeolists, and sanitarians.

As can be seen in Table IV, the greatest requirements were for chemists and biologists. The chemists were required mostly in manufacturing firms, but members of the AWWA, IWPCA, and governmental agencies also reported a need for chemists. The biologists were needed most by government agencies. (See Tables 2 and 3 of Appendix IV for the distribution by organizational groups of the 87 professionals needed each year in physical and life sciences.)

Table V - EMPLOYMENT and REQUIREMENTS for SOCIAL SCIENTISTS

Occupation	Number Employed	Additional Staff Needed Now	Average Annual Recurring Requirement
Economist - Water Resource	6	4	2
Land Use Geographer	0	1	1
Water Resources Planner	0	1	1
Other Social Scientists Urbanology and Sociologists	3	1	1
TOTAL	9	7	5

The survey indicates that the present and anticipated needs for social scientists in the water resources and pollution control field are very small. The low number probably reflects the minimal amount of attention that the social and behavioral sciences have given to the development of water and other natural resources and related problems. Because of the growing interests in man's overall environment, more of the social scientists could conceivably become involved in water and pollution control developments. Admittedly, the social science disciplines will probably never be considered water resource or environmental control scientists as such, but they can and should apply their expertise to many related problems.

For details of the returns from government agencies and Universities in Indiana concerning scientists, please see Tables 2, 3, and 4 of Appendix V. Highlights of greatest manpower needs from these tables are summarized in Table VI.

Table VI - REQUIREMENTS for SCIENTISTS in GOVERNMENT AGENCIES and UNIVERSITIES

Occupation	Number Employed	Additional Staff Needed Now	Average Annual Recurring Requirement
Soil and Water Conservationist	139	21	25
Soil Scientist, Agrogeologist	34	6	6
Biologist, Wildlife	52	3	2
Sanitarian (Life Scientist)	23	0	4
Chemist - Water	19	6	3
Biologist, Aquatic	12	7	3
Forester, Watershed Management	9	3	3
Other Life Scientists*	45	26	7
Other Physical Scientists*	61	20	12
TOTAL	394	92	65

Although the total number of personnel required in the life and physical sciences is substantial there is no category with the exception of the soil and water conservationist and the soil scientist, agrogeologist where the annual requirement is very large (see Table VI). In practically all the categories, the training involved would conceivably be that which is now given in the specific discipline; i.e. a "water chemist" would essentially be a chemist. There are some exceptions, such as the "aquatic biologist" who would need a different type training than a "molecular biologist" or a "sanitarian" (more specific in certain subjects). It is generally considered that with adequate counseling, a student could prepare himself for any of the professional physical and life sciences with the curricula and special courses now offered in our universities.

Soil and water conservationist and soil scientist, agrogeologist requirements mainly come from one agency - the Soil Conservation Service. Training presently received in agronomy or related areas is probably adequate to fill the requirements. There probably can be some curricula adjustments to fulfill specific needs of the students and meet requirements in the water resources and environmental control fields.

It would appear that special action is needed to train an adequate number of these professionals to meet the serious present shortage and future annual requirements. The data in this report should be used to help recruit and counsel qualified student applicants by informing them of the significant number of existing staff vacancies and growing future requirements -- conditions offering favorable career opportunities.

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*For details of the returns from government agencies and Universities, see Tables 2 and 3 of Appendix V.

10. Employment and Future Requirements for Engineering Technicians, Life Science and Physical Science Technicians. -- In the questionnaire mailed to Indiana manufacturing firms, water works and pollution control activities, eight technician occupations were listed and defined. Respondents could add any others appropriate. (Appendix II includes these titles and definitions.) However, due to the higher degrees of specialization involved in government agencies and universities, the list was expanded from 8 to 12 engineering technician occupations, and 7 physical science plus 3 life science technician occupations were added to their questionnaire. (Please see Table 5 of Appendix V for detailed returns in each occupation.) Table VII below presents the summary of employment and requirements for engineering technicians, and Table VIII the requirements for physical and life science technicians.

Table VII - EMPLOYMENT and REQUIREMENTS for ENGINEERING TECHNICIANS

Occupation	Number Employed	Additional Staff Needed Now	Average Annual Recurring Requirement*
Engineering Aide, Hydraulic	115	19	27
Water and Sewage System Supervisor and Technician	68	58	25
Wastewater Treatment Plant Technician	101	17	20
Water Treatment Technician	176	16	16
Air Pollution Control Technician	17	12	14
Industrial Waste Technician or Inspector	21	7	8
Solid Waste Disposal Technician	16	7	7
Sanitarian Technician	25	6	4
Other Engineering Technician	38	8	11
TOTAL	577	150	132

*See p. 9 for formula used.

It is noteworthy that the respondents to this survey reported a need for 150 additional engineering technicians to their staffs now, and that an annual recurring requirement exists for 132 engineering technicians. The large majority of these job vacancies and future requirements pertained to water and wastewater treatment (91 vacancies and 61 technicians needed each year). Other significant needs were 12 job vacancies and 14 air pollution control technicians needed annually, as well as for engineering aides, hydraulic and industrial waste technicians or inspectors. For the distribution details of the 159 technicians needed each year, by organizational groups, please see Table 3 of Appendix IV.

Table VIII - EMPLOYMENT and REQUIREMENTS for PHYSICAL and LIFE SCIENCE TECHNICIANS

Life Science Technicians

Occupation	Number Employed	Additional Staff Needed Now	Average Annual Recurring Requirement
Laboratory Technician (Sanitary Microbiologist-Water)	1	4	2
Aquatic Biologist Technician	0	1	1
Physical Science Technicians			
Soil and Water Conservationist Technician	105*	15	18
Analytical Chemist - Water Technician	3	2	2
Weather Chart Preparer (Meteorological Plotter)	2	0	1
Weather Observer (Meteorological Aide)	0	0	1
Hydrographer or Meteorological Technician	1	1	1
Meteorological Equipment Repairman	0	2	1
TOTAL	112	25	27

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*Applied only to the surveys returned by government agencies, colleges, and universities in Indiana.

As can be seen in Table VIII, the most significant physical science technician requirement was for soil and water conservationist technicians. Due to the unique nature of this work and the fact most of these technicians were employed in the U.S. Dept. of Agriculture Soil Conservation Service headquartered in Indianapolis, a special letter was sent to the Service asking about the applicability of the proposed associate degree pollution control curriculum. The reply[7] pointed out that the curriculum is quite adequate for technicians entering the field of pollution control, but goes beyond the needs of most soil conservation service technicians. (The primary responsibility of these technicians is the planning, design, and installation of soil and water conservation practices. These practices include mechanical and vegetative practices to control the flow of runoff water without erosion.) Control of pollution from erosion and sediment results from conservation and proper land use - but these soil technicians do not deal directly with sewage treatment and pollution. Undoubtedly though, a few pollution control technicians could be gainfully employed in soil and water conservation practice.

In no other category of Life and Physical Science Technicians, does there appear to be a great need, (at least not enough to consider recommending the development of a special curriculum). The reported needs could be met in part by adaptation of the proposed pollution curriculum to the extent that more emphasis is given in particular courses or areas of interest. Also the possibility exists of meeting some of these needs by graduates of the currently offered Chemical Technology program.

11. Comparisons of State Needs for Technicians: National Study vs. State Survey. -- In Section 2 of this report, an attempt was made to identify Indiana's needs for technicians in water and pollution control, based on its proportionate share of National population. The U.S. Dept. of Interior projected new nation-wide manpower needs in water and sewage treatment as 18,900 technicians and 18,500 operators. Indiana's proportionate share (based on 2.5% of total population) was computed to be a total additional requirement for 475 technicians and 450 plant operators. Inasmuch as the U.S. report was essentially a five year projection (1967-72) the annual average requirement for new jobs in Indiana becomes 95 technicians and 90 operators, a total of 185. In addition to these new positions, attrition from the more than 5,000 technicians and operators must be met. The survey conducted as part of this manpower study resulted in a reported requirement of 114 technicians and operators needed annually in the water and wastewater areas. Since no effort was made in this study to expand the returns to include non-respondents or those not surveyed, the manpower requirements identified in the U.S. Dept. of Interior report and this study appear to be reasonably comparable and support each other.

12. Employment and Requirements by Region in Indiana. -- The State of Indiana has been divided into six regions to facilitate University Extension administration. They are:

Region 1. Calumet Region, made up of Lake County;
Region 2. North Central Region, seven north central counties (*viz.* the South Bend Area);
Region 3. Northeastern Region, the 15 counties around Allen County (*viz.* the Fort Wayne Area);
Region 4. Lafayette Region, the 13 counties around Tippecanoe County;
Region 5. Central Region, the 19 counties around Marion County (*viz.* the Indianapolis Area), which includes the greatest population and largest work-force; and
Region 6. Southern Region, made up of the remaining 37 southern counties which covers the largest geographic area.

Inasmuch as Purdue University course and program offerings are planned and administered on this regional basis, it was deemed advisable to show the current and projected manpower situation for each region. The detailed presentation is included as Appendix VI to this report. Some of the highlights are presented below:

Engineers... The largest numbers of engineers working in pollution control were reported by respondents from Region 5 (Central or Indianapolis Region), wherein there were 339 jobs reported - with 74 of them vacant, and an average annual recurring need for 50. Most of these annual requirements were reported by government agencies (25) followed by industry. The second largest requirements were in Regions 1 and 2* (Eight Northwest corner counties). Respondents here reported they had 240 engineers now working in pollution control jobs, an additional 23 job vacancies, and an average annual recurring need for 35 engineers. The majority of these recurring needs (26) were in manufacturing firms with water works second (6). (See Appendix VI for detailed requirements by occupation and type of organization for each region.)

Professionals in Physical and Life Sciences... The highest numbers employed (313), number of job vacancies (70) and average annual recurring requirements (53) are found in Region 5 (Central, Indianapolis): most of these needs were in government agencies. The next highest employment was reported from Regions 1 and 2, with relatively small recurring requirements of 11 each year: the Lafayette Region was third highest in the state, requiring some four professionals in physical and life sciences per year. Needs in Regions 1 and 2 were reported for manufacturing industries, and Purdue University reported the need in Lafayette.

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*Data for these two extension regions (Calumet and North Central) can be combined as they are small (geographically) and they are contiguous.

Technicians... The largest numbers of technicians employed and needed in pollution control were also reported from Region 5 (Central, Indianapolis). There were some 414 technicians employed and staff vacancies existed for an additional 122. The annual recurring requirement for technicians in Region 5 alone was 104; (however, this figure includes 18 soil and water conservationist technicians who do not all require education to the associate degree level) the majority of all technician positions in Region 5 were in government agencies followed by water works and then industry. The next largest number of jobs and requirements were reported from Regions 1 and 2* where 129 technicians were employed in pollution control and 14 additional staff technicians are needed now. The average annual recurring requirement was for 23 technicians, mostly in manufacturing industries followed by water works. In the Southern Region, a total of 17 technicians were needed each year, most of them in water works. (For detailed requirements for each technician occupation, by region and type of organization, please see Appendix VI.)

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*Data for these two extension regions (Calumet and North Central) can be combined as they are small (geographically) and they are contiguous.

CHAPTER III

EDUCATIONAL IMPLICATIONS for POLLUTION CONTROL TECHNICIANS and NEEDS for GRADUATES of a RELATED PROGRAM

13. The Pollution Control Technology Curriculum Hypothesis. -- It was stated earlier in this report (Sec. 3), and confirmed in U.S. Senate Document No. 49[5] that the education and training for professionals (engineers and scientists) was generally satisfactory, but this is not the case for pollution control, water and wastes technicians, in which there are a variety of jobs. An examination of the duties and responsibilities of these various technicians and supervisors* disclosed a significant similarity of needed knowledge and understandings. It was also recognized that industry has been prolific in introducing changes in procedures and equipments - and that graduates must have a sufficiently broad educational base to better assure their potential to adapt effectively in the future. Therefore, in addition to obtaining quantitative manpower requirements information for professionals and technicians, it was decided to ascertain if a proposed two-year associate degree program with a core of selected technical and supporting courses, could serve a variety of technician level occupations related to the fields of pollution control, sanitation, water and wastes. Further, a review of six different curricula for sanitation, sanitary engineering, and environmental health technicians showed a remarkable commonality of specific course offerings.[10] Please see Appendix VII for curricula comparisons.

*Example: Extract from job descriptions from Indiana State Personnel Division:

1) Water Works Supervisor, Class No. 3012, Annual Salary Range $7200-9000.

Requirements for Work. Working knowledge of facilities, equipment, machines, material, and practices of both simple and complex water treatment and distribution systems. Working knowledge of the chemistry, bacteriology, and modern sanitation practices involved in the production, treatment, and distribution of safe potable drinking water. Ability to consult with, advise, and instruct plant operators on correct treatment procedures and compliance with sanitation and health requirements.

2) Sewage Works Supervisor, Class No. 3011, Annual Salary Range $7200-9000.

Requirements for work. Knowledge of machines, equipment, materials and practices of sewage treatment plant. Working knowledge of the chemistry, bacteriology, and modern sanitation practices involved in sewage treatment. Ability to consult with, advise, and instruct plant operators on correct operating procedures and compliance with health requirements.

Both positions included this provision in Experience and Educational Requirements: Accredited college or university training may be substituted on a year for year basis for either or both general or supervisory experience, with a maximum substitution of four years; (a total of eight years' experience was required).

The survey and proposed curriculum were reviewed by members of the Air and Water Pollution Committee of the Indiana Manufacturers Association, Indiana Water Pollution Control Committee, Indiana Section of the American Water Works Association and others. Assistance and general concurrence was obtained in all cases. Therefore the following hopothesis was formulated:

> A single associate degree curriculum can be developed which contains the technical core (physical and life science and pollution technology) and supporting courses needed to prepare a technician at job entry level for a variety of positions in the fields of air pollution, water and wastewater treatment, sanitation, water resources, and liquid and solid wastes disposal.

The objectives of such a program were worked out, the courses considered applicable were identified (pollution control, physical and biological, sciences, and related technical and nontechnical areas), and the general contents of needed new courses were developed.

14. Testing the Hypothesis. -- The members of the advisory committee agreed that the proposed pollution control technology curriculum would provide a broad technical base sufficient to enable graduates to enter a variety of technician-level positions in the pollution control, water and wastewater, sanitation, and waste fields. In essence, this technical base is comprised of a combination of selected physical and biological sciences and engineering technology courses. Discussion of the proposed two-year associate degree program with a number of other faculty members and representatives in these fields in industry and government (resulting in some modifications to the draft curriculum) prepared the way for the next phase of testing the hypothesis: viz. - obtaining comments as to the weaknesses and/or adequacy of the proposed curriculum and ascertaining the need for graduates of such a program from appropriate government agencies and operating activities.

It was decided to incorporate the pollution control technology curriculum as a part of the manpower survey. In the letter of transmittal, a brief explanation was made of the program - and the objectives and proposed courses of the curriculum were included with the survey. The survey respondent was asked to review these materials - and indicate if he would employ the graduates - and if so, how many? The starting monthly salary was also requested, and comments on the adequacy of the curriculum were asked for. (See Appendix II for sample copy of questionnaire used.)

The same letter and curriculum were sent to a variety of firms as noted in Section 6 of this report. The answer to the question of whether or not the graduate would be acceptable to manufacturing firms, water treatment and wastewater plants, industrial and other wastes, government and educational agencies, (that is, whether the basic hypothesis was sound or not) came in loud and clear. The graduates of the proposed pollution control technology program were wanted, their salaries would be reasonable, and the curriculum was generally adequate. (Many constructive suggested changes and recommendations were received which when applied should further improve the program.)

15. Revised Pollution Control Technology Curriculum. -- A special Ad Hoc curriculum committee was organized when it was confirmed that a single curriculum could be designed generally to meet a variety of technician-level jobs in air and water pollution, water resources and sewage disposal, environmental health, sanitation and related fields. This committee was able to improve on the draft curriculum used in the survey (Appendix II) by carefully reviewing the survey returns, the comments and recommendations of the respondents, discussions with faculty members and other experts, and review of the literature.

As a result of this work, the objectives were more specifically spelled out (as pertain to the student and with regard to the program as a whole), the courses were defined in more detail and some revisions in courses were made, requirements for new courses were developed further, and a revised program evolved as presented in Appendix VIII. (This curriculum is being examined by other Purdue School committees and undoubtedly will be further improved in time.) The curriculum devised by the Ad Hoc committee is comparable with the six environmental health and sanitation curricula in other two-year college programs, with the Purdue program varying only slightly from the average courses and emphases of the other six programs.

In emphasizing the applied side of pollution control courses, it is believed advantageous to visit (and to the degree possible use as a training facility) the water treatment, wastewater and other plants or operations serving the community.

Note: The value of introducing a specialized technical course in the first semester was recognized by the Ad Hoc Committee, Among the advantages which occur as a result are: 1. It provides motivation and maintains interest in the field;
2. It makes it possible for the student to achieve greater depth of understanding in specialized subjects in later stages of the two-year program;
3. The student sees immediate application of the principles he studies in the basic sciences and related mathematics courses.[11]

16. Needs for Pollution Control Technology Program Graduates. -- As pointed out in Section 10, requirements were reported for 150 qualified technicians (to fill existing job openings) and it was determined that an annual recurring requirement exists for 132 technicians per year (to fill existing job openings over a five year period and meet attrition and expansion needs). These requirements were reported by the respondents to the survey - and no attempt has been made to expand to the universe of non-respondents or those not surveyed. These requirements - of themselves - justify the establishment of the pollution control technology program on a manpower quantitative basis: the favorable comments and constructive suggestions (many of which have been incorporated), justify this program on a qualitative criterion basis as well.

17. Salaries of Technicians. -- One of the ways to validate the requirements for graduates is to ascertain what the beginning salaries of new, inexperienced graduates might be compared with other technicians. In the questionnaires sent to the members of the Indiana Manufacturers' Association, Indiana Water Pollution Control Association, and Indiana Chapter of the American Water Works Association, the question was asked, (if graduates of the proposed pollution control technology would be hired) what their estimated starting salary would be? The average salary was reported as $590 per month: 43 survey returns reported salary offerings of more than $600 per month. The highest salaries were reported by Indiana manufacturing firms, where some 30 technicians are needed on an average each year. It is unlikely that (many) graduates would seek employment in the seven firms reporting salaries of $450 or less. An analysis of the data indicates that there are more existing job vacancies for technicians (proportionately) in those firms and agencies reporting the lowest salaries. The range, distribution, and average salaries; and the job vacancies and future requirements are summarized in Table IX.

Table IX - SUMMARY of PRESENT NEEDS for POLLUTION CONTROL TECHNOLOGY GRADUATES, FUTURE REQUIREMENTS and SALARIES for the IMA, AWWA, IWPCA MEMBERS

	Monthly Salary Distribution, Average, and Median										Need for Graduates	
	Less than $401	401-450	451-500	501-550	551-600	601-650	651-700	$700+	Average Salary	Median Salary	Number Needed Now	Average Annual Recurring Requirements
IMA	1	2	5	2	5	1	2	3	$610	$600	17	30
AWWA	2	2	5	10	6	5	2	0	$551	$550	50	35
IWPCA	0	0	11	4	19	19	5	6	$582	$575	51	24
Total	3	4	21	16	30	25	9	9	$590	$590	118*	90*

*The totals become 175 technicians needed now and 159 technicians needed on an average each year when requirements for government and education are added.

As can be seen in Table IX, lowest salaries were reported by members of the American Water Works Association. In fact, 11 took pains to write comments on the survey returns to the effect they were concerned that present financial constraints would limit their ability to hire qualified personnel. As discussed later in this report, the examination and certification of water works operators or supervisors is voluntary in the State of Indiana; most communities with public water supplies do not have any certified personnel.

The average reported starting salaries for pollution control technicians is only slightly below the salaries of other two-year technology program graduates. The Purdue University Placement Service reported[12] that the average accepted salaries of applied technology (two-year curricula) graduates for June, 1968, was $609. This compares with the average of $590 reported by respondents to this survey in pollution control.

Baccalaureate and associate degree graduates currently being employed into the Indiana State Civil Service System are not paid according to the regular GS (Government Service) pay scale as are other state employees. Most of these degree holders are paid according to the following scaled pay-grade schedule;

Pay-grade	Monthly Pay
40	$600
38	$550
31	$400

Starting salaries for baccalaureate degree graduates average $600 per month, while starting salaries for associate degree graduates range from $400 to $550 per month.

A problem in the salary field occurs in the Federal Civil Service, where the two-year associate degree program graduate begins as a GS-4, which pays $5,145 per annum, or $429 per month. This is well below the average pay that technician graduates are receiving in the private sector.

It is hoped that this manpower report salary data might be instrumental in helping to justify the raising of some of the lower reported salaries of survey respondents (especially in water and sewage works and governmental agencies) to be more competitive.

18. Comments of Survey Respondents Concerning Proposed Pollution Control Program. -- Each respondent was asked if he had any additional comments on the program or proposed curriculum. There were 182 special letters or comments of commendation or praise for the program. There were 29 comments that indicated some negative position: 17 of these said essentially that their pollution control operations at this time were too small or limited to warrant the employment of a technician; eight reported technicians are too expensive to hire; and four reported that agreements with unions precluded hiring an employee at the technician level (in effect, it was explained that employees attained this occupational level through experience and seniority -- a problem becomes readily apparent if some employees with seniority are not /academically/ qualified to cope with more advanced and complex systems or technical job requirements).

There were very helpful and meaningful suggestions on the proposed curriculum. The majority of these comments suggested emphasis be placed on practical and applied laboratory work experience and working knowledge of the related chemistry.

More detailed comments are presented in Appendix X.

19. Possible Student Interest in a Pollution Control Technology Curriculum. -- One of the important considerations needed in the support of any new or substantially revised program is evidence concerning the extent to which there are students ready to enroll in the proposed curriculum. This information is required by the Council of Representatives in the School of Technology whenever approval for a new or substantially revised curriculum is requested.

In the case of the proposed program in pollution control technology, there are at least four facets which pertain:

First; it is suggested that scholarship funds be obtained for students to encourage their participation.

Second; all respondents to this survey who have indicated a need for these technicians can be requested to advise their local high schools and communities of the program,

Third; the public in general and counselors, parents, and potential applicants in particular should be advised of the gainful employment and projected career opportunities in this growing field, and

Fourth; an indication of student interest can be derived from an analysis of the survey of Indiana High School Seniors being conducted under the auspices of the Indiana Vocational Technical College. (These data should be available by the summer of 1969.)

20. Reinforcing the Hypothesis. -- The idea of a single curriculum to prepare for a variety of occupations related to pollution control is not altogether new. A step in this direction is being taken by the Charles County Community College, LaPlata, Maryland. In 1966, this college began a project to design and present a two year curriculum in "Pollution Abatement Technology."13/ The primary goal is the training of technical manpower in the fields of water pollution and waste management for a variety of jobs in operating agencies, regulatory agencies and industry. (Included now are wastewater and water treatment fields, with a solid waste option being developed.) The project describes a number of specific career opportunities for graduates. For example, in operating agencies the technician might be a treatment plant operator, treatment plant supervisor, field technician, laboratory technician or industrial waste technician. In regulatory agencies the technician may be called a field technician, sanitarian, field supervisor, or laboratory technician: this individual will need a more thorough understanding of pollution abatement regulations. Technicians in both operating and regulatory agencies must have the ability to meet and deal with the public. The technician employed in industry must be proficient in a variety of duties. The method of treatment and pollution abatement may be somewhat different with each type of industry and the treatment process may vary in each separate plant. The technician must have the knowledge needed to monitor, control, and maintain the effectiveness of a variety of present systems and be able to improve them or help develop new systems or methods.

The same rationale that is evident in the Charles County Community College project pervades the planning in the pollution control technology program which is the subject of this study.

21. Examination and Certification of Technicians. -- During the past few years the technician has achieved increasing stature. There is a national trend to examine and to certify, register or license more technicians. Wherever this has been done, there has been an upgrading of personnel, better assurance of their qualifications, increased pay, and progress in meeting changing and advancing requirements. Some cases in point are airplane and powerplant mechanics, licensed practical nurses and registered nurses. Examples of registration and cerficiation include The American Registry of Radiologic Technologists[14], and the Institute for the Certification of Engineering Technicians[15]: these groups are in fact, forming societies for qualified applicants, e.g., The American Society of Radiologic Technologists[16], and the American Society for Certified Engineering Technicians.[17]

Certification of water works operators... Water works operators in Indiana, at the present time, may voluntarily take one of a variety of written exams in order to become "certified". Although this has served to help upgrade personnel (200 operators certified since 1959), only about 12 percent of Indiana communities with public water supplies have one or more certified operators. The certification program is administered by a committee of the Indiana Section -- American Water Works Association. The committee always has a representative of the Indiana State Board of Health and one member from Purdue University. Importantly, legislation is now being considered by the Indiana General Assembly to make certification of water works operators mandatory.

The content of the proposed pollution control technology curriculum is such that those who complete it should be capable of successfully passing the water operator certification examination. The members of the present AWWA Certification Committee who have reviewed this curriculum have endorsed it. Representatives of the Indiana State Board of Health have also endorsed this proposed training and curriculum. It follows that a compatable method of certification is almost inevitable should a certification program administered by the State Board of Health become mandatory through legislative action. (Please see Appendix IX for more details.)

Certification of wastewater treatment plant operators... "All wastewater treatment plants (in Indiana), whether publicly or privately owned, must be under the supervision of an operator whose competency is certified to by the commissioner in a classification corresponding to the classification of the plant to be supervised." This extract from Indiana Law[18] is designed to assure the adequacy of the skill, knowledge and experience the operator in responsible charge must have to successfully supervise the operation of the plant so as to protect the public health and prevent unlawful pollution. The proposed pollution control technology curriculum is designed in part to enable the student to pass satisfactorily one of the State Board of Health's Wastewater Plant Operators examinations.

Atmosphere pollution technicians... As yet, there are neither means nor requirements for certification of these or other pollution or waste control technicians in Indiana. (For example, new regulations and standards are now being formulated in the air pollution field.) It is believed that in time, certification of a variety of other technicians will become a reality.

22. Teacher Education for Environmental Technology. -- The National Sanitation Foundation is offering scholarships to support teachers in training who will teach courses in environmental control. It is called the "Program of Teacher Education for Environmental Technology" (POTEET). The amount of training underwritten may vary with a given trainee's background and needs, but will ordinarily not exceed one year. The teacher-trainee may spend approximately half his time on his own campus (where employed), the other half taking courses at a university within commuting distance - and short trips to study the development and application of standards in the field of environmental control.[21] This POTEET program appears to be directly applicable for the preparation of teachers in the proposed pollution control technology curriculum.

23. Use of Advisory Committees and Consultants. -- Almost all successful technical education programs are supported by and demonstrate the benefits of advisory committees and special consultants.[22] The support and assistance of the committee can be very valuable, especially in planning, initiating and providing public support for the program. When students graduate and seek employment, the committee may assist in placing them in jobs and help evaluate their performance: modifications may be made in the program as a result of these evaluations. Members may also assist in providing consultants or part-time instructors. Therefore, there should be a special advisory committee for the pollution control technology program. It's membership may include representatives from appropriate operating managements, employers, government, as well as members of the Indiana Chapter - American Water Works Association; Indiana Water Pollution Control Association; and the Air and Water Pollution Study Committee of the Indiana Manufacturers Association.

24. Student Membership in Associations and Societies. -- Technical, professional, and specialized associations and societies are often primary organizers and disseminators of knowledge, procedures, techniques and methods of application in the world of work. They play an important role in our rapidly changing technological society. Their publications contain timely and authentic information. It is therefore quite necessary that memberships not only include leaders and operators in related fields - but also include educators, administrators, and students.

The Indiana Section - AWWA started a student membership program some years ago and has pushed it vigorously in recent years. There seems every reason to believe that it could be modified and extended to include associate degree students in the Pollution Control Technology program. The Indiana Water Pollution Control Association members have recently begun discussions on possible student membership in their Association as well.

Note: The general manpower situation is exemplified by the "Report of the City Engineer's Office of Lafayette, Indiana, for 1968". This annual report contains the usual statistics and technical data, but it also presents a broader picture by including personnel. Mr. James W. Morrison, superintendant of the city's sewage treatment plant and assistant city engineer writes: "There is an opportunity and a challenge in the field of pollution abatement... good waste control requires good individual attitude, knowledge and effort. No matter how modern the plant design or how efficient the process, the people who operate it must maintain eternal vigilance against the escape of offensive wastes.... The need for operator training is vital." Morrison says employment in the field of pollution control depends largely on rate of pay, job stability, advancement opportunity, and economic security after retirement.

25. Need for other Short Courses, Seminars, or Work Shops. -- Purdue University and the Indiana State Board of Health have long recognized the need to raise the level of competence of water and wastewater plant personnel. They have sponsored in-service and "short" training programs and courses for more than 20 years. Participation has been almost exclusively by operators on the job and total enrollments represent only a small fraction of all operators in the state. In order to obtain an idea of present needs in this area, one question in the survey asked "What courses, programs, seminars or other training actions are needed?" The following summarizes the result:

	IMA	AWWA	IWPCA
Desired training, short or refresher courses, and seminars (Total).	40	9	20
Wastewater Treatment	11	1	7
Solid Waste Disposal (Industrial & Sanitary)	10	5	5
Air Pollution	9	0	2
Water Treatment	8	1	6
Other	2	2	-

An analysis of these comments revealed that the level of most of the desired training was at the operator/technician level, with a few professional engineers wanting short courses. The greatest number of responses indicating needs for short courses came from Region 5 (Central Indiana - Indianapolis). Next largest needs were expressed from Regions 1 and 2 (Northwest and North Central) and Region 3 (Northeast). Specific comments included "Limit to one or two days", "One to two weeks course with credit", "Night courses preferred", and "Need correspondence courses."

CHAPTER IV

DISCUSSION, CONCLUSIONS and RECOMMENDATIONS

26. Discussion. -- Too rapidly for most of us to understand fully, the world that we know and have known is changing. We have made spectacular gains in methods of producing the needs and luxuries of life. But technological advances are being bought at the cost of increasing deterioration of the environment; pollution of air and water, waste accumulation, crowding and congestion, and loss of desireable living conditions.... There is worry that even if man's material needs can be satisfied, the world he lives in will be less suited to maintaining those human qualities that make men fit company for one another.[20]

And - money isn't pollution removal -- "A gold-plated pollution treatment plant isn't worth a tinker's dam without trained specialists to run it."[6] These and other frank and blunt statements make the vital point that we need more depth of technical manpower at all levels to meet the problems and extract full benefits from current spending and on the scales that are required in the future.

Educators, particularly those of land grant universities, have serious responsibilities in serving their society. One of these is to provide appropriate educational opportunities to enable people to lead full and productive lives under ever changing conditions. The combination of providing occupational opportunities and solving some problems of society occurs in the fields of pollution and environmental control - thus, a team of educators and citizens was assembled to obtain some facts on the present and projected manpower requirements - and the needs for educational or training programs - in these fields.

27. Conclusions. --

1. An already serious and growing problem exists in the State of Indiana (as well as in the Nation) due to the shortage of qualified professional and technical personnel in the fields of pollution and environmental control and water resources. More than 600 questionnaires received from industrial and utility firms, government agencies and educational institutions in Indiana reported that there were existing job vacancies for:

139 engineers,
112 professionals in physical and life sciences, and
175 technicians.*

These same respondents will have job openings each year for:

116 engineers,
87 professionals in physical and life sciences, and
159 technicians.*

(A summary of these requirements is presented on the next page in Table X. Specific data for each occupation - by Regions in Indiana and by organizational groups are presented in Appendix VI.)

The above requirements reflect only the needs of respondents to the questionnaire. No attempt has been made to inflate the data to include nonrespondents of the survey or those not surveyed. As such, they must be interpreted as the lower parameter of needs. They are largely substantiated by a recent U.S. Dept. of Interior Study.[2] [5]

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*Normally equivalent to graduates of two-year college, associate degree programs.

Table X - AIR and WATER POLLUTION, WATER RESOURCES, and SOLID WASTE DISPOSAL SUMMARY of MANPOWER REQUIREMENTS

Organization	Number of Engineers			Number of Professional Physical and Life Scientists			Number of Technicians Includes: Engineering and Science		
	Employed	Job Vacancies	$\bar{x}$ Annual Requirements	Employed	Job Vacancies	$\bar{x}$ Annual Requirements	Employed	Job Vacancies	$\bar{x}$ Annual Requirements
AWWA[1]	122	24	19	21	8	4	237	50	35
IWPCA[2]	90	23	18	24	2	4	72	51	24
IMA[3]	319	38	46	101	10	13	155	17	30
Govt. Agencies[4]	154	47	29	298	75	56	211	52	62[5]
Colleges and Universities[4]	35	7	4	96	17	10	14	5	8
TOTALS	720	139	116	540	112	87	689	175	159[5]

[1] Indiana Chapter of the American Water Works Association

[2] Indiana Water Pollution Control Association

[3] Indiana Manufacturer's Association

[4] Federal and State Government Agencies and Institutions Located in Indiana

[5] Includes 18 Soil and Water Conservationist Technicians (See Section 10).

2. The serious existing shortages and projected requirements for engineers and other professionals in the physical and life sciences, and the technician occupations as related to pollution and environmental control and water resources, mandate an increasing emphasis on the recruiting of qualified student applicants and the offering of appropriate courses of instruction. Particularly acute requirements exist for:

a. Engineers qualified in the fields of:

Air pollution, sanitary engineering, wastewater treatment, water supply, hydraulics, and solid waste disposal. Most of these engineers are required in the Central (Indianapolis) Region by government agencies and industry, with the next largest needs in manufacturing firms located in the Northwest Sector of the State.

b. Professionals qualified in the fields of Physical and Life Sciences to include:

Chemistry, soil and water conservation, biology, soil-science - agrogeology, and sanitation. Most of these professionals are required in the Central (Indianapolis) Region in government agencies. The next largest requirements were reported from the Northwest Sector of the State and the Lafayette Region, where manufacturing firms, colleges and universities were in need.

c. Technicians (includes operators, supervisors, field and laboratory technicians, and inspectors) qualified in air and water pollution and environmental control, water resources, and sanitation to include:

Water and wastewater treatment, engineering aides (hydraulic), air pollution, industrial and solid wastes.

Technicians are needed for a variety of jobs in operating plants and agencies, regulatory agencies, industry, and educational fields. Most of these technicians in Indiana are employed and needed in the Central (Indianapolis) Region for governmental agencies, water and wastewater plants and industry. The next largest requirements are in the Northwest Sector of the state in manufacturing firms and water works. (About 20 percent of present technician-level jobs are vacant according to respondents of the survey.)

3. The education and training curricula, in general, are adequate for professionals in engineering and in the physical and life sciences. Some special counseling and course selections will undoubtedly be required to qualify students in specific areas of water resources, pollution control, sanitation or allied fields. The numbers of graduates are inadequate - and some slight curriculum modifications may be necessary. In the case of technicians, however, there are both quantitative and qualitative problems.

4. An examination of the duties and responsibilities of various technician jobs in pollution and environmental control, sanitation and waste disposal disclosed a significant similarity of needed knowledge and understandings. Further, a review of six different two-year college curricula for sanitation, sanitary engineering, and environmental health technicians showed a remarkable commonality of specific courses. It was therefore reasoned that a single curriculum might be designed which contained the technical core and supporting courses needed to prepare a technician at job entry level for a variety of positions in the fields of air pollution, water and wastewater treatment, sanitation, water resources, and liquid and solid wastes disposal. This proposed curriculum was sent to more than 3000 Indiana addressees for comments as to its adequacy or weaknesses. With minor adjustments, it was found to be adequate and highly desirable. Graduates of the program were wanted - with beginning pay comparable to that of other two-year associate degree graduates. (There were a few cases reported where the pay level of operator technicians was very low.)

5. In order to emphasize the applied side of pollution control technology courses, it would be beneficial to utilize community water treatment, wastewater, and industry pollution control plants for field trips and as training facilities to the maximum extent feasible. Summer employment for students in these plants should also be arranged.

6. Every wastewater treatment plant in Indiana must be operated under a supervisor who has been examined and certified as competent, for the particular plant classification he supervises, by the state health commissioner. Selected representatives of the Indiana State Board of Health have reviewed and endorsed the proposed two-year pollution control technology. The General Assembly of Indiana prescribed this mandatory certification in an Act passed in 1967... as of 1 July 1968, severe penalties were in effect for violators.

7. At the present time, in Indiana, the examination and certification of water works operators is voluntary. Only 83 out of 593 communities now have certified operators working in their water plants.* Although Purdue University has offered related upgrading courses and seminars for 20 years, only 200 water works operators have been certified since 1959. The certification program is administered by a committee of the Indiana Section - American Water Works Association... the members of this committee who have reviewed the proposed two-year pollution control technology program have endorsed it. There are current efforts to enact legislation which would require that each water works plant supervisor be certified in the future.

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*The reported salaries for water works personnel was the lowest of the five organizational groups surveyed. Undoubtedly there is a relationship between certification and salary level.

8. Although competency of water works and wastewater plant operators and supervisors may now be ascertained through current examination and certification procedures, such is not yet the case for air pollution, solid waste disposal, sanitation or other environmental control technicians. However, standards and operating regulations are being developed and applied progressively in these fields as well. It is believed that in time, further identification of responsibilities and the examination and certification requirements for personnel will be accomplished.

9. It is also concluded that the objectives of a pollution control technology program must include student capabilities to meet the academic requirements for certification and/or satisfactorily complete the examinations for related occupations.

10. Careful follow-up of graduates is needed in order to help evaluate the applicability and effectiveness of the courses and experiences provided in the curriculum and the competency of the graduates.

11. It is recognized that a problem may exist in obtaining sufficient numbers of students to enroll in a pollution technology curriculum. Scholarships, present gainful job opportunities in a variety of fields, growing future requirements, adequate public relations and effective counseling all bear on the solution. Girls as well as boys should be advised of career opportunities in the broad fields of environmental control and sanitation.

12. There is a general awareness of the need to upgrade current personnel and to prepare qualified new personnel in subject fields of work. Continuing education courses have been offered throughout the state... there is a substantial need for offering short courses, seminars and work shops in wastewater treatment, waste disposal, water treatment and air pollution. Most of these needs are in Central and Northern Indiana (in the major metropolitan areas).

13. Provisions have been made for special student membership in the Indiana Chapter of the American Water Works Association and provisions for student membership are under consideration by the Indiana Water Pollution Control Association.

14. There are current offerings of scholarships by the National Sanitation Foundation to support teachers in training in environmental control subjects. Assistance to faculty members may be possible at both regional campuses and the Lafayette campus - either in technical fields or in professional education.

15. Use of advisory committees and special consultants will undoubtedly result in support and other benefits to the pollution control technology program.

***

Special Note: In a study by the U.S. Department of Interior it was reported that 50,000 persons are employed nationally as plant operator assistants and in maintenance of sewerage systems.5/ Indiana's pro-rata share (based on 2.5% of national population) would be 1,250 assistant operators and maintenance men. Assuming a 15% attrition rate, this would mean approximately 175 new assistant operators and maintenance men are needed annually in Indiana sewerage plants. These men would benefit greatly from planned on-the-job training supplemented by appropriate vocational-technical training courses. The use of correspondence courses should also be considered.

28. Recommendations. --

1. It is recommended that this study be used to stimulate the recruitment of students into the disciplines of engineering, physical and life sciences as relate to air and water pollution control, environmental control, water resources, sanitation and allied fields. The number of current job vacancies and growing projected requirements offer considerable opportunities to qualified applicants.

2. Wherever feasible in the educational preparation of engineers and other professionals in the physical or life sciences, adequate counseling should be provided and courses should be designed to embrace the pollution control, sanitation, and allied aspects.

3. It is recommended that Purdue University offer a two-year associate degree pollution control technology program, and the curriculum proposed (Appendix VIII) be used as a guide.

(Note: Due to the expertise and facilities available, pilot courses can be developed at the Lafayette Campus - and the complete program can then be initiated in the Northwest Section of Indiana and at Indianapolis where the greatest needs exist.)

4. It is recommended that arrangements be made with community water and wastewater treatment, and industry pollution control plants, to use their facilities for field trips and training purposes to the maximum extent feasible. Summer employment for students in these plants should also be arranged.

5. Attempts should be made to aquire funds for scholarships for pollution control technology program students.

6. Opportunities to attend courses in the pollution control curriculum should also be provided to people already working in the field who need additional training.

7. The competence of graduates on the job and their career progress, as well as the applicability and effectivness of the courses and experiences provided in the curriculum should be ascertained through follow-up surveys and studies.

8. It is recommended that the data in this study be used by officials to raise the level of pay for technicians in pollution control jobs where comparisons reveal particularly low levels.

9. The extent of high school seniors' interests in careers in pollution control should be ascertained by an analysis of the results of the Indiana Vocational Technical College survey now being conducted..

10. An advisory committee for the proposed two-year pollution control technology curriculum should be formed to assist in the planning, implementation and needed continuing support of the curriculum and in the recruitment of qualified students.

11. Short courses, seminars, and work shops should be offered in the fields of wastewater treatment, solid waste disposal (industry and sanitary), water treatment, and air pollution. The operators and technicians in the Central and Northern Regions of Indiana (in the major metropolitan areas) have the greatest requirements. Night and correspondence courses should be presented.

12. The job vacancy, projected recurring annual requirements and materials presented in this study should be used to:

a. Indicate the current and growing opportunities in subject fields, (to potential students - both boys and girls, counselors, parents, educators, industrialists, business men, and others).

b. Justify the development of the curriculum and the acquisition of resources necessary for program implementation.

c. Provide impetus to the further development and applications of examinations and certification of technicians in water, pollution, waste, and environmental control fields.

d. Encourage members of industrial firms, businesses, civic organizations, government and educational offices to support and expand efforts to improve water resources and sanitation and in the abatement of pollution, to take positive action to recruit and help prepare qualified personnel in related fields, and to advise the public in related matters.

13. It is recommended that the offerings by the National Sanitation Foundation to help support teachers in training who will teach in environmental control programs be exploited.

14. Planning for and development of on-the-job training guides and vocational-technical courses for plant operator and maintenance assistants should be accomplished and made available throughout the state. Correspondence courses may offer good possibilities.

15. It is recommended that efforts continue to provide specialized and supplemental courses related to pollution, environmental control and sanitation for students enrolled in the Schools of Engineering and School of Science, as well as at Graduate School level. The large and growing career opportunities in these fields and in related research should be pointed up in counseling students.

Appendix I

SELECTED BIBLIOGRAPHY

Reference Number	Title
1.	The Reader's Digest Family Reference Series - "These United States", Copyright 1968, The Reader's Digest Association, Inc. p. 113.
2.	"Manpower and Training Needs in Water Pollution Control" Report of the Dept. of the Interior Federal Water Pollution Control Administration to the Congress of the United States, in Compliance with Public Law 89-753, August 2, 1967; Document No. 49, Senate, 90th Congress, 1st Session. p. 1.
3.	"What is Inland Doing for Water Pollution?" The Inland Steelmaker, Vol. 14, No. 3, East Chicago, Indiana, Feb. 8, 1968, pp. 1 and 6.
4.	"Air Pollution Control Under Way", The Hoosier Farmer, March, 1968, p. 43.
5.	"Manpower and Training Needs..." op. cit. p. 2.
6.	"Money Isn't Pollution Removal." Editorial, Engineering News-Record, March 28, 1968, p. 68.
7.	Letter from M. T. B. Evans, State Conservationist, U.S. Dept. of Agriculture, Soil Conservation Service, 311 W. Washington Street, Indianapolis, Indiana, December 17, 1968.
8.	Graduate Training in Air Pollution Control, memorandum from Dr. D. L. Brenchley, School of Civil Engineering, Purdue Univ., 31 January 1969.
9.	"Your Career in Sanitary Engineering - Toward A Healthier World." Public Health Service Publication No. 579, U.S. Dept. of Health, Education and Welfare, Public Health Service p. 7.
10.	Letter and Enclosures from Mr. John Reddington, National Sanitation Foundation, 2355 West Stadium Blvd., Ann Arbor, Michigan 48106, September 20, 1968.
11.	Criteria for Technician Education, A Suggested Guide, OE-80056; U.S. Dept. of Health, Education and Welfare, Office of Education, November 1968, p. 58.

Appendix I (continued)

SELECTED BIBLIOGRAPHY

Reference Number	Title
12.	Purdue University Placement Service Report, "Accepted Salaries of Graduates - 1968."
13.	Pollution Abatement Technology, based on information provided by Belva L. Jensen, Chairman, Biology Dept., Charles County Community College, LaPlata, Maryland. *Water and Sewage Works*, January 1969, pp. 20-22.
14.	*The American Registry of Radiologic Technologists*, Executive Director, R. C. McGowan (ARRT), 2600 Wayzata Blvd., Minneapolis, Minnesota. 55405.
15.	The Certification of Engineering Technicians, *Institute for the Certification of Engineering Technicians*, (Sponsored by the National Society of Professional Engineers) 2029 K Street, N.W., Washington, D.C. 20006.
16.	*The American Society of Radiologic Technologists*, Executive Secretary, G. J. Eilert (RT), 537 So. Main Street, Fond du Lac, Wisconsin 54935.
17.	*The American Society of Certified Engineering Technicians*, ASCET Information Center, P.O. Box 40230, Everman, Texas 76140.
18.	*Chapter 273, Acts 1967 - Indiana* (S.234) approved March 11, 1967, Sec. 6.
19.	*Ibid*., Introductory paragraph.
20.	An Environment Fit for People, by Raymond F. Dasmann, *Public Affairs Pamphlet No. 421*, The Public Affairs Committee, 381 Parke Avenue, South, New York 10016, p. 1.
21.	"Teacher-Training Scholarships", November 1, 1968, National Sanitation Foundation, P.O. Box 1468, 2355 West Stadium Blvd., Ann Arbor, Michigan 48106; Mr. John Reddington, Project Director.
22.	Criteria for Technician Education. *op*. *cit*. pp. 18-19.

PURDUE UNIVERSITY
SCHOOL OF TECHNOLOGY
LAFAYETTE, INDIANA 47907

Appendix II

OFFICE OF MANPOWER STUDIES

May 15, 1968

Survey Package

Letter of Transmittal, Questionnaire, Proposed Pollution Control Curriculum, and Occupational Descriptions.

Dear Sir:

The matters of air and water pollution, liquid & solid waste disposal, and water supply & resources are of increasing importance and seriousness. Properly trained people are required in growing numbers to handle the many problems in these fields.

Purdue University is anxious to help meet the related educational needs. To do this, we need information concerning manpower requirements and opinions on the adequacy of educational programs: we hope you can help us.

The attached survey has been designed to obtain selected manpower data, such as numbers employed and future needs - and asks for your judgements on a proposed 2-year college-level associate degree educational program for pollution control technicians. The survey has been reviewed by the members of the Indiana Manufacturer's Association Air and Water Pollution Control Committee and professions in water supply.

Working together, we may be able to prepare qualified people to help cope with these serious problems. Will you please fill out this survey and return it in the enclosed envelope at your earliest convenience?

Many thanks!

Sincerely yours,

Lisack

J.P. Lisack, Director
and Associate Professor

JPL:ct

Attachments

Appendix II (continued)

WATER RESOURCES and
POLLUTION CONTROL TECHNOLOGY
MANPOWER SURVEY

Please return to Prof. J. P. Lisack
Purdue University School of Technology
Lafayette, Indiana 47907

Name________________________

Title________________________

Number or employees in your local firm____________

Firm or Organization________________________

Address________________________

____

____

Occupation*	Number Now Employed in each Occupation	Additional Staff Needed Now	Estimated number needed from outside sources to fill vacancies and new jobs for next five years
PROFESSIONAL CATEGORY (Bachelor or Higher Degree)			
ENGINEERS			
Sanitary Engineers (General)			
Water Supply Engineers			
Wastewater Treatment Engineers			
Air Pollution Control Engineers			
Solid Waste Disposal Engineers			
Radiological Protection Engineers			
Hydraulic Engineers			
Other Engineers (Identify)**			
PHYSICAL OR LIFE SCIENTISTS (Related to Water Resources & Pollution Control)			
Bacteriologists			
Biologists			
Chemists			
Industrial Hygienists			
Other Scientists (Identify)			

*Definitions are attached; need not be returned with completed survey.

**Related to Water Resources and Pollution Control.

Appendix II (continued)

Occupation*	Number Now Employed in each Occupation	Additional Staff Needed Now	Estimated Number Needed from outside sources to fill vacancies and new jobs for next five years
TECHNICIAN CATEGORY(Associate in Applied Science Degree..2-year College Program)			
Air Pollution Control Technician			
Engineering Aide, Hydraulic			
Industrial Waste Techn. or Inspector			
Sanitarian Technician			
Solid Waste Disposal Technician			
Wastewater Treatment Plant Technician			
Water & Sewage System Supvr. and Technician			
Water Treatment Technician			
Other Technician(Identify)**			

Proposed Pollution Control College Program

1. Would you be interested in employing graduates of a two-year Associate Degree program for Technicians such as outlined on the following page? Yes____ No____

2. If yes, how many per year, or how frequently? ____________________
What do you estimate would be their starting monthly salary? $____________

3. Any comments on the adequacy of the proposed curriculum?
____
____

4. What other courses, programs, seminars or other training actions are needed? Please explain and indicate probable extent of your participation if offered.
____
____
____
(Use back of sheet if necessary)

*Proposed curriculum and occupational definitions are attached; they need not be returned with completed survey.
**Related to Water Resources and Pollution Control.

School of Technology
Purdue University

Dr. Harvey Wilke
Professor of Sanitary Engineering
Purdue University, Lafayette, Ind.

POLLUTION CONTROL TECHNOLOGY (Proposed Program)

The Pollution Control Technology Program is being planned in response to the rising concerns with problems of pollution in the control of liquid, gaseous, and solid wastes. This program of study is designed to prepare students for employment as technicians in water and wastewater treatment plants, governmental pollution control agencies, industrial pollution control, water supply, water resources, engineering consulting firms, city engineering offices, and related activities.

Emphasis is placed upon the technician's role in pollution control functions, utility distribution and collection system layout, surveys, and sampling and testing procedures. Appropriate courses are taken in mathematics; physical, chemical and biological sciences, and fundamental engineering practices. Courses are included which deal with communications and human relations factors.

Students accepted in this 2-year program of study are high school graduates who are interested in and capable of college level work.

FRESHMAN YEAR

(1st Semester)

Course No.	Title	Credit
CET XXX	Introduction to Pollution Control	2
CET 104	Elementary Surveying	3
CHEM 119	General Chemistry	4
ENGL 101	English Composition	3
MATH 151A	College Algebra and Trigonometry	5
MET 100	Slide Rules & Calculations	1
		18

(2nd Semester)

Course No.	Title	Credit
EG 110	Drafting Fundamentals	3
CET 209	Land Surveying and Sub-Division or Elective*	3
SOC 100	Introduction to Sociology	3
BIO 220A	Introduction to Microbiology	4
GNT 136	Physics: Mechanics & Heat	4
		17

SOPHOMORE YEAR

(3rd Semester)

Course No.	Title	Credit
CET XXX	Sanitary Chemistry and Biology	4
CET XXX	Water Supply Operations	4
CET 253	Hydraulics & Drainage	3
SPE 114	Principles of Speech	3
GNT 176	Physics: Electricity, Sound and Light	4
		18

(4th Semester)

Course No.	Title	Credit
CET XXX	Air Pollution Control	3
CET XXX	Solid Waste Disposal	2
CET XXX	Wastewater Treatment	4
CET XXX	Specifications, Contracts and Estimating	3
GNT 220	Technical Report Writing	3
	Elective*	3
		18

*Possible Electives:

Course No.	Title	Credit
CHEM 110	Qualitative Analysis	4
ECON 210	Principles of Economics	3
IS 152	Human Relations in Industry	3
IS 268	Elements of Law	3
MATH 223A	Differential Calculus	3
MATH 224A	Integral Calculus	3
PSY 120	Elementary Psychology	3
GEOS 230	Survey of Meteorology	3

Note: CET is Civil Engineering Technology
GNT is General Studies Technology
EG is Engineering Graphics
MET is Mechanical Engineering Technology

1 May 1968

PROFESSIONAL CATEGORY

ENGINEERS OCCUPATIONS Related to

Air and Water Pollution, Wastewater, Solid Wastes, Water Resources and Radiological Management

1. SANITARY ENGINEER - Protects and promotes the public health by inventing, designing, appraising, managing engineering projects which improve physical environmental conditions, and prevents damage to the public health by investigating and improving those engineering works (and other projects) which are or may become faulty. As a Sewage Disposal Engineer, determines limit of waste loads within assimilative capacity of stream to insure meeting quality standards, and computes stream flow needed to assimilate waste loads following varying degrees of treatment.

2. WATER SUPPLY ENGINEER - Designs and oversees construction and operations of water supply plants and systems. Estimates costs of projects and prepares specifications for equipment and materials. Is competent in areas such as chemical coagulation, sedimentation, rapid sand filtration, water softening (conditioning), taste and odor removal, iron removal, floridation, and chlorination.

3. WASTEWATER TREATMENT ENGINEER - Designs and oversees construction and operations of wastewater disposal system. Estimates cost of projects and prepares specifications for equipment and materials. Directs installation of screens, grit chambers, sedimentation and sludge tanks, digesters, filtration devices, and other equipment to treat and dispose of wastewater.

4. AIR POLLUTION CONTROL ENGINEER - Assists with the management of the air by sampling, testing, and designing facilities and equipments that improve the environment of man. Ensures compliance with ordinance requirements and regulations.

5. SOLID WASTE DISPOSAL ENGINEER - Designs and oversees construction and operation of waste disposal plants and systems. Estimates costs of projects and prepares specifications for equipment and materials. Is competent in areas such as incineration; sanitary land fill; composting; demolition of buildings; and the handling, burial or disposal of poisonous or radioactive materials.

6. RADIOLOGICAL PROTECTION ENGINEER - Is responsible for the monitoring of sources of radioactivity that may, when uncontrolled, be harmful to mankind. May sample, test, and design necessary related facilities and equipments.

7. HYDRAULIC ENGINEER - Designs and oversees construction of power, irrigation, and navigation projects for control and use of water. Computes and estimates rates of water flow. Specifies type and size of equipment used in transporting water and converting water power into electricity. Stabilizes streams or open waters by dredging, digging cutoffs, placing jetties, and constructing levees. Designs and builds artificial channels, conduits, and mains to transport and distribute water, and plans reservoirs to insure adequate storage water for projected demands, plans pressure valves, and booster stations to obtain proper water pressure at all levels. May build laboratory models to study construction and flow problems.

(over)

PROFESSIONAL CATEGORY (continued)

PHYSICAL AND LIFE SCIENTISTS

1. BACTERIOLOGIST (Microbiologist) - Studies growth, structure, development, and characteristics of bacteria and other micro-organisms. Identifies, isolates and makes cultures of micro-organisms under controlled conditions; observes their action upon living tissues of plants, higher animals, fish, etc. and on other micro-organisms and on dead organic matter. Makes chemical analyses of acids, alcohols and enzymes produced by bacteria or other micro-organisms.... (Includes Industrial Bacteriologist who, for example, is concerned with fermentation processes, determines best methods of using micro-orgamisms to reduce organic industrial waste to useful substances, tests for means and materials inhibiting growth of micro-organisms causing deterioration of [organic origin] products.)

2. BIOLOGIST - Studies origin, relationship, development, anatomy, function, and basic principles of plant and animal life. (Includes Aquatic Biologist who studies plants and animals living in water and environmental conditions affecting them; e.g. water temperature, acidity, light, oxygen content and other physical conditions. Also includes Cytologist, who studies plant and animal cells, structures, reproduction, growth, atypical or malignant changes, and the influences of physical or chemical factors.)

3. CHEMIST (Pollution Control) - Performs non-routine qualitative and quantitative chemical analyses. Conducts laboratory experiments to develop or evaluate new analytical methods and/or products for pollution control. Uses instrumentation such as Infrared Spectrometry, Gas Chromotography and Atomic Absorption Spectrophotometry. Advises other disciplines by interpreting analytical data and writing technical reports. Directs the performance of routine analytical work. May be classified under the following general fields: Analytical, Inorganic, or Organic.

4. INDUSTRIAL HYGIENIST - Conducts health programs to eliminate or control occupational health hazards and diseases. Collects samples of dust, gases, vapors and other potentially toxic materials for analysis. Investigates ventilation, exhaust equipment, sound level, lighting, and other conditions which may affect health. Conducts radiological evaluations and recommends measures to assure employee protection. May work with others to institute control and remedial measures for hazardous conditions and equipment. Prepares reports and makes recommendations for control and correction of hazards.

TECHNICIAN CATEGORY*

OCCUPATIONAL DEFINITIONS FOR

POLLUTION CONTROL, WATER RESOURCES AND SOLID WASTE DISPOSAL PERSONNEL

AIR POLLUTION CONTROL TECHNICIAN

Collects air samples for routine monitoring, for special studies and to ensure compliance with regulations. Installs, services, maintains, and repairs sampling equipment. Performs qualitative and quantitative tests on samples. Operates, maintains, services, and repairs miscellaneous air pollution control equipment. Prepares reports of special studies and keeps records of activities.

ENGINEERING AIDE, HYDRAULIC (Technician level)

Aids the Hydraulic Engineer in the design and construction of power, irrigation and navigation projects for control and use of water. Performs the routine tasks involved including the building of laboratory models and the study of operation and maintenance problems.

INDUSTRIAL WASTE TECHNICIAN OR INSPECTOR

Inspects industrial wastes collection and disposal facilities. Investigates sources of industrial wastes to ensure conformance with ordinance and permit requirements. Collects samples from industrial plants, drainage systems and the treatment facility. Makes laboratory determination on samples. Compiles reports of investigations and findings and recommends actions needed. May assist in operating, maintaining, and servicing industrial waste treatment facilities.

SANITARIAN (Technician level)

Plans, develops, and executes environmental health programs. Enforces regulations concerned with food processing and serving, collection and disposal of solid wastes, sewage treatment and disposal, plumbing, recreational areas, air pollution and radiation.

*Normally has an educational level and/or experience the equivalent to an accredited two year college (Associate Degree) type program.

(over)

TECHNICIAN CATEGORY (continued)

SOLID WASTE DISPOSAL TECHNICIAN

Collects solid waste samples and conducts qualitative and quantitative laboratory determinations on these samples. Makes collection route studies, advises on methods and techniques of collection operations. Makes operational studies of the effectiveness of the disposal method. Maintains records of collection and disposal data and prepares reports of special studies.

WASTEWATER TREATMENT PLANT TECHNICIAN

Makes laboratory determinations to control treatment processes in the operation of wastewater treatment plants. Collects wastewater samples for routine and special analysis. Adjusts dosages of chemical feeders, performs preventive maintenance tasks, observes safety requirements, services equipment, and makes minor repairs to equipment. Has responsibility for miscellaneous wastewater plant operational duties. Maintains operational records.

WASTE AND SEWAGE SYSTEM SUPERVISOR OR TECHNICIAN

Supervises men engaged in installing, maintaining, repairing, and servicing water distribution and sewage collection facilities. These may include pipes, valves, hydrants, regulators, elevated storage tanks, lift stations, and control equipment. Inspects work to determine conformance to specifications. Enforces safety procedures, prepares work programs, writes reports and maintains records. Coordinates activities with other utilities and with street and highway departments.

WATER TREATMENT TECHNICIAN

Makes laboratory determinations to control treatment processes in the operation of water treatment plants. Collects water samples for routine and special studies. Adjusts dosages of chemical feeders, washes filters, performs preventive maintenance tasks, services equipment, makes minor repairs, observes safety requirements, and undertakes miscellaneous treatment plant operational duties. Maintains operational records.

Appendix III

SURVEY RETURNS DISTRIBUTION by INDUSTRY GROUPS for the INDIANA MANUFACTURERS ASSOCIATION RESPONSE

Manufacturing Industry Group	Number of Firms Responding	Number Employed in Firms Responding	Total Number Employed in State	Percent of Total State Industry Group Represented
Ordnance & Accessories	1	7,500	18,489	40.6%
Food & Kindred Products	47	9,438	43,067	21.9
Textile Mill Products	1	235	671	35.0
Apparel & Fabrics Products	3	315	13,993	2.3
Lumber & Wood Products, (Ex. Furn.)	13	1,130	11,148	10.1
Furniture & Fixtures	17	4,584	24,811	18.5
Paper & Allied Products	13	1,791	15,145	11.8
Printing, Publishing, & Allied Industries	8	4,099	27,205	15.1
Chemicals & Allied Products	17	14,377	26,809	53.6
Petroleum Refining & Allied Industries	3	4,700	7,094	66.3
Rubber & Misc. Plastic Products	24	11,320	30,261	37.4
Leather & Leather Products	1	75	2,597	2.9
Stone, Clay, Glass, & Concrete Products	18	10,680	25,261	42.3
Primary Metal Industries	38	64,545	110,427	58.5
Fabricated Metal Products, etc.	63	11,494	53,225	21.6
Machinery, Except Elec.	66	16,538	67,265	24.6
Elec. Mach., Equip. & Supplies	35	35,942	124,219	28.9
Transportation Equipment	40	95,700	100,251	95.5
Professional & Scientific Products, Industries	5	1,702	5,997	28.4
Misc. Manufacturing Indus.	7	677	9,844	6.9
Other	1	3,750	4,107	91.3
TOTALS	421	300,592	718,136	41.9%

Appendix IV

ANNUAL RECURRING MANPOWER REQUIREMENTS by MEMBERS of SPECIFIC ORGANIZATIONAL GROUPS

Table 1 - ANNUAL RECURRING REQUIREMENTS for ENGINEERS

Engineering Occupational Fields	Representative firm membership in:					
	IMA[1]	AWWA[2]	IWPCA[3]	Gov. Agencies[4]	Colleges and Universities[5]	Total
Air Pollution Control	18	2	0	4	1	25
Sanitary	3	3	6	7	1	20
Wastewater Treatment	9	5	3	0	0	17
Hydraulic	1	1	1	10	1	14
Water Supply	2	2	4	0	1	9
Other	6	1	0	1	1	9
Solid Waste Disposal	2	4	0	2	0	8
Architectural	0	0	4	0	0	4
Mechanical	3	0	0	0	0	3
Radiological Protection	1	1	0	0	0	2
Water Resources Planning	0	0	0	1	1	2
Chemical	2	0	0	0	0	2
Civil	0	0	0	1	0	1
TOTALS	46	19	18	29	4	116

1. Indiana Manufacturers Association
2. Indiana Section - American Water Works Association
3. Indiana Water Pollution Control Association
4. State and Federal Government and Educational Institutions in Indiana.

Appendix IV (continued)

ANNUAL RECURRING MANPOWER REQUIREMENTS by MEMBERS of SPECIFIC ORGANIZATIONAL GROUPS

Table 2 - ANNUAL RECURRING REQUIREMENTS for PROFESSIONALS in PHYSICAL and LIFE SCIENCES

Field of Science	Representative firm membership in:					
	IMA	AWWA	IWPCA	Gov. Agencies	Colleges and Universities	Total
Bacteriologists	0	1	1	1	0	3
Biologists	1	0	0	6	2	9
Chemists	9	3	3	4	0	19
Industrial Hygienists	1	1	1	0	0	3
Other Scientists	0	0	0	45	8	53
TOTALS	11	5	5	56	10	87

Appendix IV (continued)

ANNUAL RECURRING MANPOWER REQUIREMENTS by MEMBERS of SPECIFIC ORGANIZATIONAL GROUPS

Table 3 - ANNUAL RECURRING REQUIREMENTS for TECHNICIANS (ENGINEERING and SCIENCE)

Technicians Fields	Representative firm membership in:					
	IMA	AWWA	IWPCA	Gov. Agencies	Colleges and Universities	Total
Air Pollution Control	8	1	1	4	0	14
Engineering Aide (Hydraulic)	3	2	1	20	1	27
Industrial Waste	3	2	1	2	0	8
Sanitarian	1	2	1	0	0	4
Solid Waste Disposal	1	2	0	3	1	7
Wastewater Treatment	6	8	2	4	0	20
Water and Sewage System Supervisor	1	8	13	3	0	25
Water Treatment	4	8	3	1	0	16
Other	3	2	2	25*	6	38*
TOTALS	30	35	24	62	8	159

*Includes 18 soil conservation service technicians, see Section 10 for discussion.

Appendix V

SUMMARY of SURVEY RESPONSE FROM GOVERNMENT AGENCIES and UNIVERSITIES

Table 1 - ENGINEERS

Engineering Occupational Field	Now Employed			Vacancies Now			Vacancies Next 5 Years			Total Needed Next Five Years
	Agencies	Universities	Total	Agencies	Universities	Total	Agencies	Universities	Total	
1. Sanitary	36	7	43	13		13	24	2	26	39
2. Water Supplies	5	4	9		1	1	2	2	4	5
3. Wastewater Treatment		3	3		1	1		1	1	2
4. Air Pollution	2	2	4	8	1	9	12	2	14	23
5. Solid Wastes Disposal		2	2	2		2	8	1	9	11
6. Radiological Protection	1	2	3	1	2	3	3	2	1	3
7. Hydraulic	83	10	93	16	1	17	35	2	37	54
8. Civil	1		1				1		1	1
9. Industrial Hygiene	3		3	4		4	6		6	10
10. Water Resources Planner	23		23	3		3	7		7	10
11. Systems		1	1		1	1		1	1	2
12. Air Photo Interpreter		2	2							
13. Soils		2	2					1	1	1
TOTALS	154	35	189	47	7	54	97	13	110	164

Appendix V (continued)

SUMMARY of SURVEY RESPONSE FROM GOVERNMENT AGENCIES and UNIVERSITIES

Table 2 - LIFE SCIENTISTS

	Now Employed			Vacancies Now			Vacancies Next 5 Years			
Life Scientists	Agencies	Universities	Total	Agencies	Universities	Total	Agencies	Universities	Total	Total Needed Next Five Years
1. Aquatic Biologist	3	9	12	6	1	7	5	1	6	13
2. Fishery Bacteriologist										0
3. Fish Culturist	4		4				2		2	2
4. Fish Management	12	1	13	1	1	2	3		3	5
5. Forester - Watershed Management	5	4	9	2	1	3	12		12	15
6. Microbiologist - Water	1	7	8	1		1	3	2	5	6
7. Wildlife Biologist	43	9	52	3		3	5		5	8
8. Sanitarian	23		23				18		18	18
9. Radiological Physicist	1		1	22		22	1		1	23
10. Botanist	1		1							
11. Plant Physiologist		2	2							
12. Plant Ecologist		5	5							
13. Parasitologist		2	2							
14. Medical Entomologist		1	1							
15. Limnologist		1	1							
16. Algaologist								1	1	1
17. Biologist		7	7		1	1		2	2	3
TOTALS	93	48	141	35	4	39	49	6	55	94

Appendix V (continued)

SUMMARY of SURVEY RESPONSE FROM GOVERNMENT AGENCIES and UNIVERSITIES

Table 3 - PHYSICAL SCIENTISTS

Physical Scientists	Now Employed			Vacancies Now			No. Needed Next 5 Years			Total Needed Next Five Years
	Agencies	Universities	Total	Agencies	Universities	Total	Agencies	Universities	Total	
1. Chemist - Water	15	4	19	5	1	6	9	1	10	16
2. Climatologist	1	7	8		3	3	3	5	8	11
3. Oceanographer		4	4		1	1	0	4	4	5
4. Hydrologist	4		4	7	1	8	6		6	14
5. Hydrogeologist	11	7	18				3	1	4	4
6. Soil & Water Conserv.	134	5	139	19	2	21	98	4	102	123
7. Soil Scientist-Physical	1	7	8		1	1	1	4	5	6
8. Soil Scientist-Agrogeol.	27	7	34	3	3	6	19	3	22	28
9. Meteorologist		7	7	1		1		4	4	5
10. Bacteriologist	3		3	3		3	3		3	6
11. Chemist - Air	2		2	1		1	3		3	4
12. Chemist - Radiological Health	2		2				2		2	2
13. Chemist - Industrial Hygiene	2		2				2		2	2
14. Engineering Geologist	3		3	1		1	2		2	3
15. Physical Geographer					1	1		1	1	2
TOTALS	205	48	253	40	13	53	151	27	178	231

Appendix V (continued)

SUMMARY of SURVEY RESPONSE FROM GOVERNMENT AGENCIES and UNIVERSITIES

Table 4 - SOCIAL SCIENTISTS

	Now Employed			Vacancies Now			No. Needed Next Five Years			
Social Scientists	Agencies	Universities	Total	Agencies	Universities	Total	Agencies	Universities	Total	Total Needed Next Five Years
1. Economist - Water Resource	4	2	6	3	1	4	4	1	5	9
2. Other Social Scientists										
Urbanology and		1	1					1	1	1
Sociologists		2	2		1	1		1	1	2
3. Land Use Geographer				1		1	1		1	2
4. Water Resources Planner				1		1	3		3	4
TOTALS	4	5	9	5	2	7	8	3	11	18

Appendix V (continued)

SUMMARY of SURVEY RESPONSE FROM GOVERNMENT AGENCIES and UNIVERSITIES

Table 5 - ENGINEERING, LIFE SCIENCE, and PHYSICAL SCIENCE TECHNICIANS

	Now Employed			Vacancies Now			Vacancies Next Five Years			
TECHNICIAN CATEGORY (Associate Science Degree--two-year College Program)	Agencies	Universities	Total	Agencies	Universities	Total	Agencies	Universities	Total	Total Needed Next Five Years
I. ENGINEERING TECHNICIANS										
1. Air Pollution Control Technician				8		8	12	1	13	21
2. Engineering Aide Hydraulic	94	2	96	11		11	89	2	91	102
3. Engineering Aide Hydrogeologist	2		2	1		1	2	1	3	4
4. Engineering Aide Sanitary	2	2	4	2		2	7	1	8	10
5. Industrial Waste Tech. or Inspector							10		10	10
6. Solid Waste Disposal Technician		1	1	1		1	12	2	14	15
7. Waste Water Treatment Plant Technician		1	1				20		20	20
8. Water & Sewer Systems Supervisor and Tech.	4	1	5	8		8	7		7	15
9. Water Treatment Tech.		1	1				5	1	6	6
10. Sanitarian Technician	1		1	1		1	1		1	2
11. Inspector-Water Wells										
12. Other Engineering Tech. General	2		2				1		1	1
TOTALS	105	8	113	32	-	32	166	8	174	206

Appendix V (continued)

SUMMARY of SURVEY RESPONSE FROM GOVERNMENT AGENCIES and UNIVERSITIES

Table 5 - ENGINEERING, LIFE SCIENCE, and PHYSICAL SCIENCE TECHNICIANS (ccnt'd)

	Now Employed			Vacancies Now			Vacancies Next Five Years			
TECHNICIAN CATEGORY	Agencies	Universities	Total	Agencies	Universities	Total	Agencies	Universities	Total	Total Needed Next Five Years
II. LIFE SCIENCE TECHNICIANS										
1. Aquatic Biologist Technician					1	1				1
2. Fishery Microbiologist Technician										0
3. Laboratory Technician (Sanitary Microbiologist - Water)		1	1	2	2	4	2	1	3	7
TOTALS		1	1	2	3	5	2	1	3	8
III. PHYSICAL SCIENCE TECHNICIANS										
1. Analytical Chemist - Water Technician	1	2	3	2		2	4	2	6	8
2. Weather Chart Preparer (Meteorological Aide)		2	2					1	1	1
3. Weather Observer (Meteorological Aide)								1	1	1
4. Hydrographer or Meteorological Tech.	1		1	1		1	4	1	5	6
5. Meteorological Equipment Repairer				1	1	2	3	1	5	6
6. Soil and Water Conservationist Technician	104	1	105	14	1	15	70	2	72	87
7. Other Physical Science Technicians										
TOTALS	106	5	111	18	2	20	81	8	89	109

Appendix VI

EMPLOYMENT and REQUIREMENTS by REGION in INDIANA

	Region 1 Calumet			Region 2 North Central			Region 3 Northeastern			Region 4 Lafayette			Region 5 Central			Region 6 Southern			Total Indiana		
	EMP	VAC	$\bar{x}^*$	EMP	VAC	$\bar{x}^*$	EMP	VAC	$\bar{x}^*$	EMP	VAC	$\bar{x}^*$	EMP	VAC	$\bar{x}^*$	EMP	VAC	$\bar{x}^*$	EMP	VAC	$\bar{x}^*$
ENGINEERS																					
By Occupation																					
Sanitary Engineers	18	-	2	15	3	2	6	1	-	11	-	1	60	17	10	28	9	5	138	30	20
Water Supply Engineers	20	1	1	13	1	2	6	-	-	5	2	1	38	4	4	7	-	1	89	8	9
Wastewater Treatment Engineers	34	4	3	9	1	1	6	1	1	2	-	1	17	6	7	11	6	4	79	18	17
Air Pollution Control Engineers	24	3	3	52	6	12	1	-	1	2	-	1	23	10	7	1	1	1	103	20	25
Solid Waste Disposal Engineers	4	-	-	1	1	1	2	-	1	1	-	-	5	4	3	2	5	3	15	10	8
Radiological Protection Engineers	6	-	-	1	1	-	1	-	-	1	1	-	3	2	1	-	1	1	12	5	2
Hydraulic Engineers	12	-	1	6	-	1	3	-	-	7	1	-	70	14	9	27	2	3	125	17	14
Other Engineers	13	1	4	12	1	2	24	5	2	10	3	1	49	17	9	51	4	3	159	31	21
TOTAL ENGINEERS	131	9	14	109	14	21	49	7	5	39	7	5	265	74	50	127	28	21	720	139	116
By Organizational Group																					
Ind. Mfg. Assoc. Firms	112	8	12	69	6	14	27	6	3	10	3	2	69	11	10	32	4	5	319	38	46
Ind. Sec. - Am. Water Works Assoc. Mem.	11	1	2	32	3	4	7	-	-	6	-	-	40	5	4	26	15	9	122	24	19
Ind. Water Poll. Control Assoc. Mem.	8	-	-	2	1	1	9	1	2	3	1	1	53	17	11	15	3	3	90	23	18
Colleges and Universities	-	-	-	6	4	2	6	-	-	20	3	2	-	-	-	3	-	-	35	7	4
Government Agencies	-	-	-	-	-	-	-	-	-	-	-	-	103	41	25	51	6	4	154	47	29
PHYSICAL or LIFE SCIENTISTS																					
By Occupation																					
Bacteriologists	3	-	-	-	-	-	1	-	-	2	-	-	4	4	2	3	1	1	13	5	3
Biologists	5	-	1	4	-	1	5	1	1	3	2	1	64	10	3	22	2	2	103	15	9
Chemists	27	2	3	10	3	3	22	3	3	21	-	-	22	9	7	27	3	3	129	20	19
Industrial Hygienists	6	-	-	-	1	1	-	-	-	3	-	1	2	-	1	-	-	-	11	1	3
Other Scientists	4	2	1	13	1	1	5	-	-	21	9	5	221	47	40	20	12	6	284	71	53
TOTAL SCIENTISTS	45	4	5	27	5	6	33	4	4	50	11	7	313	70	53	72	18	12	540	112	87
By Organizational Group																					
Ind. Mfg. Assoc. Firms	37	2	4	4	3	4	19	3	3	24	-	-	4	2	1	13	-	1	101	10	13
Ind. Sec. - Am. Water Works Assoc. Mem.	6	2	1	4	-	1	1	-	-	1	-	-	5	2	1	4	4	1	21	8	4
Ind. Water Poll. Control Assoc. Mem.	2	-	-	2	-	-	3	-	-	2	-	1	1	1	1	14	1	2	24	2	4
Colleges and Universities	-	-	-	17	2	1	10	1	1	23	11	6	19	-	-	27	3	2	96	17	10
Government Agencies	-	-	-	-	-	-	-	-	-	-	-	-	284	65	50	14	10	6	298	75	56
TECHNICIANS																					
By Occupation																					
Air Pollution Control Technicians	6	1	2	1	-	1	-	-	1	3	-	1	6	10	8	1	1	1	17	12	14
Engineering Aides Hydraulic	11	1	1	2	1	2	1	-	-	1	-	1	95	14	22	5	3	1	115	19	27
Industrial Waste Tech. and Inspectors	5	2	1	4	1	1	-	-	-	2	1	1	8	3	5	2	-	-	21	7	8
Sanitarian Technicians	4	-	-	3	1	1	4	-	-	1	1	1	2	3	2	11	1	-	25	6	4
Solid Waste Disposal Technicians	1	3	1	1	-	1	1	-	-	3	-	-	4	2	4	6	2	1	16	7	7
Wastewater Treatment Plant Technicians	25	2	1	6	1	1	6	-	1	11	-	2	48	10	13	5	4	2	101	17	20
Water & Sewage Sys. Supvr. and Tech.	8	-	1	2	-	-	10	-	1	4	-	1	26	48	18	18	10	4	68	58	25
Water Treatment Technicians	18	1	3	22	-	2	8	1	1	2	-	-	105	7	7	21	7	3	176	16	16
Other Technicians	8	-	2	2	-	2	4	-	-	6	5	4	120	25	25	10	3	5	150	33	38
TOTAL TECHNICIANS	86	10	12	43	4	11	34	1	4	33	7	11	414	122	104	79	31	17	689	175	159
By Organizational Group																					
Ind. Mfg. Assoc. Firms	49	4	7	6	3	5	8	-	2	7	3	3	58	6	11	27	1	2	155	17	30
Ind. Sec. - Am. Water Works Assoc. Mem.	22	4	3	26	-	3	9	-	1	17	-	2	134	26	18	29	20	8	237	50	35
Ind. Water Poll. Control Assoc. Mem.	15	2	2	7	1	1	15	1	1	2	-	1	14	38	14	19	9	5	72	51	24
Colleges and Universities	-	-	-	4	-	2	2	-	-	7	4	5	1	-	-	-	1	1	14	5	8
Government Agencies	-	-	-	-	-	-	-	-	-	-	-	-	207	52	61	4	-	1	211	52	62
SURVEY RESPONSE RECAP.																					
Number of Ind. Mfg. Assoc. Firms	37			68			99			39			115			63			421		
Ind. Mfg. Assoc. Employment	67,269			42,956			42,204			20,074			112,397			15,692			300,592		
# of firms Ind. Sec. - Am. Water Works Assoc.	7			14			20			12			24			34			111		
# of firms Ind. Water Poll. Control Assoc.	3			5			8			5			14			11			46		
Number of Colleges and Universities	-			1			2			7			4			4			18		
Number of Government Agencies	-			-			-			-			6			2			8		

*Average Annual Recurring Requirements

Appendix VII

COMPARISON of PROPOSED POLLUTION CONTROL TECHNOLOGY CURRICULUM with ENVIRONMENTAL HEALTH and SANITATION CURRICULA in SIX OTHER TWO-YEAR COLLEGES

	Purdue's Proposed Program	Other Curricula* (Semester Hours)						
		1	2	3	4	5	6	Average
Nontechnical	15	14	14	14	12	16	22	15.3
Sciences								
Mathematics	6	8	4	6	10	4	2	5.7
Biology	3	8	6	6	5	6	10	6.8
Chemistry	8		8	12		3		3.8
Physics	8	10	6	3	8	4	6	6.2
Other	4		8		8	3	6	4.1
Sub-totals	29	26	32	27	31	20	24	26.7
Related Technical								
Drafting	3	2	1	4	4		1	2.0
Hydraulics	3			3	3	2		1.3
Surveying	3	3			4			1.2
Contracts, etc.	2	3		3	2			1.3
Other		3		3	3	4	5	3.0
Sub-totals	11	11	1	13	16	6	6	8.8
Pollution Control								
Water and Wastewater	8	7	6	6	12	8	2	6.8
Air Pollution	3	3	4	2				1.5
Solid Waste Disposal	2							0.0
Environmental Health	2	4	8	3	3	11	12	6.8
Other		3	4			5	4	2.7
Sub-totals	15	17	22	11	15	24	18	17.8
TOTALS	70	68	69	65	74	66	70	x̄ 68.6

*College and Program Titles:

1 Hudson Valley Community College, Troy, N. Y.; Environmental Health Technician

2 Broome Technical Community College, Binghamton, N. Y.; Environmental Health Technician

3 Ag. and Tech College, Morrisville, N. Y.; Environmental Health Technician

4 Fayetteville Technical Institute, North Caroliana; Sanitary Engineering Technician

5 Milwaukee Technical College; Sanitation Technician

6 Ferris State College, Big Rapids, Michigan; Environmental Sanitarian Assistant

Appendix VIII

PROPOSED ASSOCIATE DEGREE PROGRAM in POLLUTION CONTROL TECHNOLOGY

OBJECTIVES of the CURRICULUM

I. With regard to the student, the objectives of the pollution control technology curriculum are:

A. General - To prepare a graduate who is:
1. Ready for employment as a technician in a variety of pollution control areas;
2. Capable of productive effort for the employer shortly after graduation;
3. Motivated to remain in contact with the changing technology of pollution control;
4. Capable of meeting the academic requirements for certification as a wastewater plant operator, water treatment plant operator, and as technicians in other pollution control areas. (See Appendix VII.)

B. Technical Competence - To prepare a person who is knowledgeable concerning:
1. Physical, biological, and mathematical sciences related to pollution control;
2. Water and wastewater treatment, solid waste disposal, and air pollution control;
3. Treatment plant operations, sampling and laboratory procedures, and the collection and recording of data;
4. Fundamentals of hydraulics, drafting, and surveying.

C. General Education - To broaden the individual through exposure to:
1. Oral and written communications;
2. Social sciences;
3. Legal aspects of contracts and specifications;
4. Elective courses directed toward a specialized area.

II. With regard to the program, the objectives are to provide a pollution control curriculum which is:

A. Adequate preparation for further education at the baccalaureate level;

B. Acceptable for accreditation by appropriate agencies;

C. Viable and responsive to the changing technology of pollution control.

SUGGESTED
REQUIREMENTS for an ASSOCIATE DEGREE
in
POLLUTION CONTROL TECHNOLOGY

FRESHMAN YEAR

Course No.	(1st Semester) Title	Credit
PCT 110	Introduction to Pollution Control	2
CET 104	Elementary Surveying	3
CHM 109	General Chemistry	4
ENGL 101	English Composition I	2
MA 151A	Elementary Mathematics	5
MET 100	Applied Engineering Computations	1
		17

Course No.	(2nd Semester) Title	Credit
EG 110	Drafting Fundamentals	3
*CHM 110	General Chemistry with Qualitative Analysis	4
SOC 100	Introductory Sociology	3
BIOL 200	Introduction to Microbiology	3
PHYS 220	General Physics	4
		17

SOPHOMORE YEAR

Course No.	(3rd Semester) Title	Credit
PCT 210	Sanitary Chemistry and Biology	4
PCT 220	Water Supply Operations	4
CET 253	Hydraulics and Drainage	3
SPE 114	Fundamentals of Speech Communication	3
PHYS 221	General Physics	4
		18

Course No.	(4th Semester) Title	Credit
PCT 221	Air Pollution Control	3
PCT 222	Solid Waste Disposal	2
PCT 223	Wastewater Treatment	4
ART 276	Contracts and Specifications	2
GNT 220	Technical Report Writing	3
	Elective	3
		17

Possible Electives:

ECON 210	Principles of Economics	3
IS 152	Human Relations in Industry	3
IS 268	Elements of Law	3
MA 223A	Differential Calculus	3
MA 224A	Integral Calculus	3
PSY 230	Elementary Psychology	3
CET 209	Land Surveying and Sub-Division	3

Note:
PCT is Pollution Control Technology
CET is Civil Engineering Technology
GNT is General Studies Technology
EG is Engineering Graphics
MET is Mechanical Engineering Technology

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*CHM 110 is being specified for the core curriculum in place of CET 209 as was originally proposed in the questionnaire. This change resulted from the repeated comments in the questionnaire for the additional chemistry.

POLLUTION CONTROL COURSES

	Class	Lab	Semester Hours Credit
Introduction to Pollution Control Disease Transmission Water Resources and Water Treatment Wastewater Treatment Air Pollution Control Solid Waste Disposal Recreational Sanitation Industrial Hygiene Food and Milk Sanitation Governmental Regulations Lab: Field Trips, Films, and Seminar	1	3	2
Sanitary Chemistry and Biology Development of skills in and knowledge of laboratory procedures applicable to: Water Treatment Wastewater Treatment Lab: Analytical Lab	2	6	4
Water Supply Operations Operations and Maintenance Chemical Dosages Equipment and pumps Feeders Distribution Systems Record Keeping Lab: Field Trips, Computations, and Analytical Lab	3	3	4
Wastewater Treatment Operations and Maintenance Chemical Dosages Equipment, Pumps, and Feeders Collection Systems Stream Surveys Record Keeping Lab: Field Trips, Computations, and Analytical Lab	3	3	4
Air Pollution Control Sources and Types of Pollution Effects of Air Pollution Sampling Procedures and Analysis Control Methods Lab: Analytical Lab	2	3	3
Solid Waste Disposal Refuse Collection Composition and Character of Refuse Sanitary Landfill Incineration Composting Lab: Field Trips, Computations and Analytical Lab	1	3	2
			19

Appendix IX

EXAMINATION and CERTIFICATION of TECHNICIANS

The training of personnel for the operation of water and wastewater treatment plants has been generally an ON-THE-JOB activity by Indiana utilities. There is extremely limited movement of operating personnel from one plant to another. When vacancies do occur, city officials frequently make appointments from a political standpoint rather than on the basis of an applicant's capability. It is regretable that frequently poorly trained individuals are placed in charge of multi-million dollar facilities, with operations critical to peoples' health.

Purdue University and the Indiana State Board of Health have sponsored in-service and "short school" training programs for over 20 years. Participation is almost exclusively by operators already on the job and the total enrollment represents only a small fraction of the operators.

Water works plant operators... A recent approach designed to upgrade the quality of water and wastewater plant operators has been a licensing or certification procedure. In 1959, a program for the voluntary certification of water works operators was started by the Indiana Section of the American Water Works Association. Since then, over 200 operators have been certified by voluntarily taking one of the various written examinations. However, these certified operators represent only 83 Indiana communities (since some cities have several certified operators): there are 593 communities with public water supplies in Indiana! The certification program therefore cannot be said to supply sufficient qualified operators -- but it does stimulate some operators now on the job to seek additional training which will further develop their abilities.

In the current Indiana Legislature, a law is being proposed to make certification of the water works supervisor mandatory. Passage of this law would increase the requirement of "certified" operators many-fold. The current situation is not good -- Indiana has practically no new, young, certified operators for a city administrator to choose from.

It is the intent that the proposed pollution control curriculum would provide the necessary training so that a capable student could pass the appropriate mandatory or voluntary certification examination when it is offered at the end of his two-year Associate Degree course.

Wastewater treatment plant operators... An act was enacted by the General Assembly of the State of Indiana in 1967 which was designed "to protect the public health and to conserve and protect the water resources of the state; to provide for classifying of all wastewater treatment plants; to require the examination and certification of operators as to their competency to supervise the operation of such plants, to prescribe the powers and duties of the state health commissioner in these matters; to provide for the promulgation of rules and regulations; and to prescribe penalties for violations of the act"[19]. This act was in full force and effect on and after July 1, 1968. So it is now required by Indiana Law that the wastewater treatment plant operator supervising the plants' operation be certified. The health commissioner has prescribed written certification examinations which are designed to test the operator in his knowledge, ability, and judgment in wastewater treatment.

As in the case of the water treatment plant operators, however, the requirements for new, young, certified wastewater plant operators far exceeds the supply.

The proposed pollution control curriculum is designed so that each student, at the end of the two-year course would also take the wastewater plant operator "certification" examination. (See Appendix VIII.) Course content is such that a capable student should be able to pass satisfactorily one of the State Board of Health's Wastewater Plant Operators examinations.

Other pollution control technicians... Although no certification for air pollution control technicians, solid waste disposal, or other environmental control personnel is currently required, the proposed associate degree curriculum does attempt to provide a background and operational knowledge to assist these individuals for competency on the job. It is believed that in time, more occupations in this field will require examination and certification or comparable actions.

Appendix X

SUMMARY of COMMENTS of SURVEY RESPONDENTS

There were 421 returns from members of the Indiana Manufacturers Association (IMA), 111 returns from members of the Indiana Section-American Water Works Association (AWWA) and 46 returns from members of the Indiana Water Pollution Control Association (IWPCA). Many respondents took advantage of the opportunity to write in their comments concerning the proposed pollution control program and curriculum. A summary and some typical comments are presented in this appendix.

	IMA	AWWA	IWPCA
POSITIVE VIEWS or COMMENTS			
Commendation or praise	90	60	32
NEGATIVE POSITIONS			
Too small a firm or operation	15	2	--
Too expensive to hire technicians	4	4	--
Union agreements preclude hiring technicians[*]	3	1	--
RESTRAINTS			
Government financial limitations or regulation requirements	6[**]	11[***]	3

[*] Union agreement essentially required that this occupational level (technician) was attained by members through experience and seniority.

[**] These IMA respondents indicated that they are complying with pollution control as the present law required---pollution-wise and personnel-wise.

[***] These AWWA respondents indicated that the existing financial structure, controlled by their local governments, could not afford the hiring of these technician graduates.

Appendix X (continued)

COMMENTS on the ADEQUACY of the PROPOSED CURRICULUM

MORE EMPHASIS ON:	IMA	AWWA	IWPCA
Laboratory work experiences (see related comments below)	7	5	-
Field work	6	-	1
Chemistry	5	2	1
Survey of instrumentation	3	-	1
Training in (sanitation/water) plant trouble shooting	3	2	-
Industrial and mechanical engineering	3	-	1
Training in (sanitation/water) plant operation	2	2	-
Industrial waste pollution control	2	-	-
Hydraulics	2	-	-
Thermodynamics and heat transfer	2	-	-
Federal, State, and local pollution regulations	2	-	-
Management, organization, and office procedure	2	1	1
Three or four year course	1	-	-
Sociology	1	1	-
Drafting	1	1	1
Biology	1	-	-
Provisions for R&D background	1	-	-
Other (mathematics, economics and English)	-	3	-
LESS EMPHASIS ON:			
Specialization	4	-	-
Sociology	-	3	-
Speech	-	3	-
Elementary surveying	-	2	-
Land surveying	-	1	-
English	-	1	-
Electives	-	-	1

TYPICAL COMMENTS PERTAINING to LABORATORY WORK EXPERIENCES

IMA MEMBER COMMENTS:

1. Use a general laboratory - train technicians in use of various instruments and equipments for conducting standard laboratory tests.
2. Quantitative analyses and instrumentation courses are needed.
3. The proposed curriculum should provide an adequate background for much of the routine work involved in pollution control activities.
4. The curriculum should include chemical analyses - especially covering standard methods.
5. Needs more work in sanitary chemistry, air sampling and analyses.

AWWA MEMBER COMMENTS:

1. The program should train a man for plant operation; more specifically, for lab work and plant trouble shooting.
2. Seems short on routine lab tests or equipment efficiency studies.

Attachment

BIBLIOGRAPHY OF MANPOWER STUDIES AND REPORTS

School of Technology, SCC-A
Purdue University
Lafayette, Indiana 47907

Office of Manpower Studies
Director, Professor
J. P. Lisack

Manpower Report — Title

65-3 - Technician-Level Educational Planning for the Chemical Technology in Indiana, 20 Oct, 1965. Examines industries related to the Chemical technology. Presents scientists, engineers, and technicians as a percent of total employment in major industries. Explains methods of computing technician requirements by industry and locale. Includes related occupational titles and sample chemical technology curriculum.

66-1 - Technician-Level Educational Planning in the Greater Lafayette, Indiana Area, Concerning the Electrical/Electronic Technology, January, 1966. Determines numbers of technicians needed annually in industries employing electrical/electronic type technicians. Examines ten year trends in local employment and projects requirements into future. Discusses occupations concerned, orientation of educational programs, curricula, and collateral items.

66-2 - Employment Trends in Five Indiana Counties, 1 February 1966. Presents population and employment trend data for significant industries to facilitate technical education and facilities planning. Compares county and state data.

66-3 - Occupations, Qualifications, and Areas of Work in Architectural, Construction and Related Fields for Jobs Above the Skilled Craftsman Level, 10 March 66. Describes selected occupations to assist faculty concerned with determining requirements for and objectives of related educational programs. Occupational titles, definitions and qualifications are shown with required education, vocational preparation, and aptitudes.

66-4 - Foundry Technicians and the Foundry Industry in Indiana, 30 March, 1966. Examines the foundry industry, manpower requirements, and the kind of educational program needed - for foundry technicians. National manpower factors are corroborated in a survey of 125 Indiana foundries: survey respondents' opinions of educational needs (by subjects and courses) are included.

66-5 - Employment Trends and Technician Needs in Wayne County, Indiana, "The Richmond Study", 4 April, 1966. Determines an approximation of the kinds and numbers of technicians needed for preliminary educational program planning. Presents economic, manpower and employment trends data as well as listings by location and description of products of the more important industries. Describes methods used.

66-6 - Methods and Rationale for Determining Technician-Level Manpower Requirements by Locale - and for a Specific Industry, 20 July, 1966. A general review of sources of manpower data, ratios, factors, and methodology related to computation of estimates of technicians for industries or for a given locale.

66-7 - Selected Technical Education Needs in Howard County, Indiana, "The Kokomo Study", 1 August, 1966. Examines manpower, industry and economic factors to identify kinds and levels of post-high school technical educational programs that may be needed. Presents results of survey wherein the needs for these identified programs are verified. Describes methods and instruments used.

66-8 - Selected Manpower and Employment Data for Delaware County, Indiana and Six Contiguous Counties, 15 August, 1966. Compiled to assist in broad initial planning for establishing regional educational and training programs. State and regional population; employment, wage and industry data; and manpower factors are included.

Manpower Report Title

66-9 - Region One Manpower Study. (N.W. Sector of Indiana) 18 October, 1966. This report is a projection - ten years into the future - for seven counties. It includes estimated changes in employment by industry and changes within occupational groups. Has special notes on needs for initial and continuing education, and on rising hiring standards.

66-10 - Manpower and Training Needs in Fluid Power, 30 November, 1966. Contains (1) Specific manpower requirements at five occupational levels in fluid power technology - with factors applicable to various major industry groups; (2) Types of educational courses needed; (3) The depth of understandings required at each occupational level in fluid power courses, and supporting technical and other courses; (4) Comments of representatives from Indiana industries. Includes methods and questionnaire used.

67-1 (Indianapolis); 67-3 (Calumet); and 67-4 (Fort Wayne) - Manpower Requirements for Industrial Illustrators and Draftsmen, (thru August, 1967). A series of reports for metropolitan areas indicated containing: (1) Background data re needs, employment, and salaries of technicians and draftsmen; (2) Occupational descriptions, qualifications, education and training; (3) Results of surveys to determine current and future needs and training program information; (4) Discussion of the impact of future technological changes on the drafting processes - and their effects on draftsmen qualifications. The hypothesis is made - and proven - that greater work complexity and advances in technology affecting the drafting processes, have made the utilization of Tracers less profitable; Job entry level is moving to the higher level of Detailer with better educational preparation.

67-2 (Indianapolis); 67-5 (Calumet); 67-6 (Fort Wayne); 68-1 (Kokomo) - Computer and Electronic Data Processing Manpower Requirements, (thru March, 1968). Reports results of research and surveys for metropolitan areas indicated concerning: (1) Background info re computers; (2) Job descriptions and qualifications of 23 computer and EDP occupations; (3) Numbers of people employed, current job vacancies and projected requirements; (4) types of equipments and nature of computer applied functions; (5) Training and educational programs; and (6) Ratios of computer jobs to total employment and job categories.

67-7 - Requirements for Personnel Staff Members and Supervisors, 28 December, 1967. Report contains factors - or ratios - of personnel staff members to total employees in each industry group. The past, present, and projected ratios and trends are developed for first-line supervisors (viz. foremen):

e.g. In 1952, there were 29 employees for each supervisor,
in the early 60's there were 20 employees per supervisor,
in 1967, there were 18 employees per supervisor, and
by 1972, there may be only 15 employees per supervisor.

The annual recurring losses, growth factors, and educational ramifications are described. Factors are applied to industries in the Northeast Region of Indiana.

68-2 - Indiana's Need for Assistants in Veterinary Medical Practice, 15 May, 1968. Study points out the needs for, identification of, description, education and control of auxiliaries to the professional veterinarian. Results of a survey of all practicing veterinarians in Indiana are presented. Report includes: (1) Titles, descriptions, duties and qualifications of animal technicians, small animal hospital attendants, livestock health attendants, and others; (2) The numbers of these auxiliaries now employed, current job vacancies, and future requirements; (3) Salary and training matters; (4) The need for licensure or registration, and methods to be used; (5) Comments of veterinarians; and (6) Related Conclusions and Recommendations.

Manpower Report

68-3 - Study of Computer Use in Medium-sized Manufacturing Firms, 1 August, 1968. This study examines the utilization of computers by medium-sized manufacturing concerns engaged in the fabrication of non-durable materials or light weight durable materials. Sampling techniques were used to acquire data from companies throughout the U.S. and a five-state midwest region by mail, plus a telephone interview with a special sample of midwest companies. The study includes: usage of EDP equipment, utilization by functional areas, estimated efficiency and dollar return on computer investment, manpower requirements and training and salary matters, major problem areas encountered and summaries of the survey findings. A review of pertinent literature is also reported in the study.

68-4 - A Proposed Land Surveyor Baccalaureate Program and the Need for Land Surveyors in Indiana, 15 September, 1968. The purpose of this study is to provide data and recommendations concerning land surveyors in Indiana. This report contains the present employment, job vacancies, and projected requirements for land surveyors. Data was acquired through questionnaires sent to all County Surveyors, the State Highway Commission and other government offices, to private practice surveying firms, and to selected firms in industry. The study establishes that substantial present and projected needs exist for land surveyors. The study provides data and information useful for related curriculum development.

A proposed baccalaureate curriculum designed to prepare professional land surveyors is included. Survey respondents indicated a favorable attitude towards the proposed program, gave some constructive suggestions, and indicated they were willing to hire graduates at reasonable salaries.

The requirements for State registration of professional land surveyors are also discussed.

NOTE: Copies of these reports are available for $1.50 per copy (Indiana Government and Educational Offices exempted). Please make check payable to Purdue University.